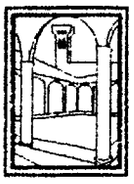


THE EUROPEAN UNIVERSITY INSTITUTE

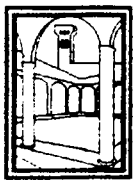
Department of Economics

Contributions to the Theory and the Empirical Analysis of Migration

Christian DUSTMANN

Thesis submitted for assessment with
a view to obtaining the Degree of Doctor
of the European University Institute.

Florence, June 1992



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I am especially grateful to John Micklewright for his support, his useful suggestions and his always critical and helpful comments on everything I wrote. He implicitly advised me to resist the seduction of pure theory, to first think about the relevance of a paper before writing it and to convince the reader that what he is reading is at least of some economic interest and empirical relevance.

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Chapter 1

Migration – A General Introduction

1.1 Migration and Research

The term (human) migration denotes the movement of human individuals between geographical regions. International migration, the main concern of this research, refers to such movements across national borders.[1] Research efforts of social scientists concentrate mainly on two aspects of migration: the causes of such movements, and the consequences for host- and source countries.[2]

Migration has too many aspects to make it a subject that is easy to deal with. The main reason for this is simple: the single migrant is a human being, and as such he is a rather complex system. He is the owner of labor which he may or may not supply to labor markets. He possesses a certain stock of human capital, which was built up in the home country. The decision whether, in which form and for how long he supplies labor to the foreign labor market is, like the migration decision itself, the result of a complex decision problem. The migrant is further a social being with preferences and a cultural identity, being usually formed in another society than the one of the host country. While the labor the migrant may sell to the foreign labor market is not distinguishable from the labor of native workers with the same level of qualification, the migrant himself is usually identifiable as a foreigner. This is a main reason for social reactions to, and political actions against migration. Migrants live and consume in the

[1] In what follows, the term *migration* will denote human, international migration.

[2] In the following chapters, the country of emigration will be referred to as *home country* or *source country* or simply *emigration country* and the country of immigration as *host country*, *target country* or *immigration country*.

host country. They create their own social context and they are directly confronted with the native population. Migrants are usually expected to integrate into the new society, but they often prefer to maintain their cultural identity and their different life style.

Different sciences are interested in different aspects of migration. When sociologists talk about migration, they usually have in mind the process of social adoption of migrants in the societies of host countries and the social consequences of migration for the source countries. Laywers may think about different legislations and regulations, and how they apply to different types of migrants and migration situations. When economists use the term migration, they usually think of the movement of the factor labor which goes with the migrant. The simplest economic explanation why migration occurs, namely wage differentials, relates only to the component labor, which is inherent to the migrant. When analyzed in a simple neoclassical framework, where migration is treated symmetrically with international capital mobility, consequences of migration are then nothing else than reactions of an economic system to changes in the supply of labor.

1.1.1 Migration and Economics

In the last two decades, numerous contributions have appeared in the economics literature that analyze the consequences of migration for both home and host countries under various perspectives. The model most frequently used is the conventional static two-sector, two-factor model of production. This model was first applied by Meade (1955) in the field of international trade theory. In this framework, the economy is assumed to consist of two perfectly competitive industries, producing two goods with linearly homogeneous production technologies. The two factors of production, typically labor and capital, are assumed to be perfectly mobile between sectors, always fully employed and fixed in supply. The production of the two goods is characterized by different factor intensities over the whole range of production possibilities, with factor reversals excluded.[3] On the demand side, individuals are usually assumed to exhibit identical and homothetic preferences.

Using this model as a theoretical basis, a variety of publications have analyzed the consequences of migration for both the source- and the host country, under different aspects and various assumptions.[4] It was for example shown that the consequences of

[3]This model is often referred to as the *Heckscher-Ohlin* model or, since Samuelson plays an important role in its development, the *Heckscher-Ohlin-Samuelson* model (Takayama, 1982).

[4]see, for instance, Kenen (1971), Bhagwati and Rodriguez (1976), Krauss (1976), Bhagwati and

migration depend on whether, and which of, the goods produced in the economy under consideration are traded, whether the flow of labor from one country to another is accompanied by a flow of capital, whether migrants re-transfer a part of their earnings to their home countries (remittances) and whether the economy is able to influence world price levels. The basic model was likewise extended to allow for three factors of production (usually skilled and unskilled labor and capital),[5] or to consider a different treatment of migrant and native labor in the host country's labor market.[6] Recently, some contributions explore the implications of migration in dynamic models. These models are generally based on neoclassical growth theory or overlapping generations models.[7]

1.1.2 Some Critical Remarks

Although all these approaches provide valuable insights into the effects of migration under the respective framework of assumptions, results are often far too general to apply to any specific migration situation. An analysis that is based on too general or simplifying assumptions may not give answers on important questions which arise with a particular migration situation. Furthermore, analysts impose sometimes strong behavioral assumptions on what they call migrants. These assumptions, although crucial for the analysis, are often counter intuitive and not justified by any evidence. Results of these studies are then misleading. It occasionally seems that the term *migration* is used by analysts to justify their sometimes technically very sophisticated and involved analytical exercises by actual relevance. In order to approach the important problem of migration in an appropriate way, one should try to analyze and to give answers on questions that are raised by specific and observed migration situations, rather than defining hypothetical migration scenarios to which specific models could apply.

The consequences of a specific type of migration for the economies of host- and home country depend crucially on the behavior of the single migrant worker. This behavior is not simply induced by rentability considerations concerning the factor labor,

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Brecher (1980), Rivera-Batiz (1982), Thompson (1984), Rivera-Batiz (1984), Djajic (1986), Ethier (1986), Gupta (1988), Quibria (1988), Quibria (1989), Rivera-Batiz (1989), Quibria and Rivera-Batiz (1989), Rahman and Caples (1991).

[5]see, e.g., Clark and Thompson (1990), Jones and Easton (1990).

[6]For instance, Ethier (1985).

[7]Galor and Stark (1991) investigate the impact of technological differences on international labor migration in an overlapping generation framework. The impact of immigration on the income position of the native population has been addressed by Barry and Soligo (1969), Steinmann (1991) and Meier and Wenig (1992).

but it is the outcome of a complex decision process. A better insight into which factors are relevant determinants in this process is an important step for a proper evaluation of the consequences of migration. An understanding of the determinants of migrants behavior will help to explain the reasons for the consequences of a specific migration situation.

The next section will provide a rough description of different features of migration and migration situations. The classification of the type of migration to be analyzed is an important presupposition not only to define the right questions to be asked, but also to choose the appropriate tools of analysis. Section 1.3 will then characterize the type of migration that is the main concern of this study, namely temporary migration or, more specifically, return migration. Finally section 1.4 will provide a general outline of the remaining chapters.

1.2 Classification and Analysis

Migration is a very heterogeneous phenomenon. One type of migration is often not comparable with another type of migration, neither in causes nor in consequences. Different countries face different migration situations. For instance, causes and consequences of guest worker migration are likely to differ quite considerably from causes and consequences of politically induced migration. Seasonal migration between Spain and Southern France or Poland and Germany has different aspects and different economic consequences than permanent migration from Western Europe to the United States or Australia.

The main questions and problems that arise are different for distinct migration situations. The tools of analysis should therefore correspond to a specific situation of interest. They should further be appropriate to provide answers on the most relevant questions that arise from this situation. For this purpose, it is as a first step useful to classify and to describe the type of migration to be analyzed. A proper classification of a specific migration situation may then help to set up the theoretical model in a way that it captures the most relevant characteristics, and that it is able to give answers on the most relevant questions. The next section presents some features that may help to identify and to classify migration situations. The following explanations are far from complete and they are only meant to provide a rough idea of different aspects of the phenomenon migration.

1.2.1 Features of Migration

Migration may be classified according to the skill level of the migrant population upon arrival in the host country. Migration of unskilled labor affects the economy, and different sectors of the economy, in another way than migration of highly skilled labor. This is true for both the host- and the source country. If migrant workers are highly skilled, the emigration country may loose considerable investments into the human capital of these workers. The extensive literature on the "Brain Drain" emphasizes the serious economic disadvantages of an outflow of highly qualified labor for the economy of the source country.[8] Restrictions of such outflows were the rule until recently in all countries of the former Warsaw Pact and are still enforced in many other countries.[9] On the other side, the economy of the host country may gain by an inflow of highly skilled labor because it saves the costs of education.[10]

The question whether the migrant population is skilled or unskilled is crucial for the evaluation of political and economical reactions in the host- as well as in the source country. A differentiation between skilled and unskilled labor inflow is necessary to study in an appropriate way the distributional aspects of migration.[11] Distributional consequences of migration are partly responsible for the phenomenon that only some groups of the host country's society oppose certain types of immigration.[12]

Accordingly, when a country exhibits heavy immigration of skilled or unskilled labor, and one is interested in the most relevant consequences of this movement for the economy of the host country, an analysis along the lines of a simple two-factor model

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[8]See, for example, Bhagwati and Rodriguez (1976), Vas-Zoltan (1976).

[9]The outflow of human capital mirrors the dilemma of many LDC's: The development of their economies depends crucially on the factor human capital. They therefore are forced to invest into the education of their people, either by sending them abroad or by developing appropriate educational structures in their own country. However, since their economies are less productive than those of "developed" countries, the rental rate paid on human capital is usually lower. Consequently, being appropriately educated on the expenses of the home country, these people often migrate to countries where they receives a higher return on their human capital.

[10]For a benefit-cost analysis of educational savings in case of guest-worker migration to West-Germany, see Blitz (1971).

[11]Some recent empirical contributions investigate the skill level of immigrants upon arrival as well as the impact of an inflow of unskilled workers on earnings of the incumbent population (see, for example, Borjas (1991), Butcher and Card (1991)).

[12]For instance, immigration of mainly unskilled labor to West Germany was strongly opposed from the mid-seventies onward by interest groups who represented mainly unskilled labor. Social groups whose members were mostly working in the skilled segment of the labor market were in favor or at least indifferent towards such immigration.

with labor being homogeneous will not provide too much insight. The extension to three factors of production (skilled labor, unskilled labor, capital) allows for a wider range of issues one may look at – for instance distributional aspects, interactions between skilled and unskilled labor and both types of labor and capital etc. In terms of a model structure, who gains and who looses from migration depends on who owns which factors of production. If the society consists of different classes with different tastes (for example, the owners of capital consume mainly capital goods while the owners of labor consume mainly consumption goods), the distributional effects will additionally depend on changes of relative product prices which are induced by migration. The analysis of individual effects of migration on classes which differ in their endowments of factors of production as well as in their demand functions requires a theoretical framework which deviates from a simple one-class economy and from identical preferences among consumers.

Migrants may further have different reasons for emigration. Economic motives are likely to always play some role for migration decisions. Differences in wages for the same labor market activity are the classical economic explanation for migration.[13] Such differences, however, were recognized to be often outweighed by what is called in the literature *psychic costs*: costs that are arising as a result of changes in the social and cultural environment, by loosing social contacts and often the social status as well.

However, economic motives are not the only reason for migration. One could well think of migration situations where economic motives play a minor role, or where a relatively unfavorable economic situation in the host country is overcompensated by other aspects, like a preference to live in the host country. This preference could be induced by political or ethnical persecution in the home country. In addition, relying on simple wage differentials as the motor of migration decisions does not allow to explain return migration, unless in the case of a drastic change in the economic situation of the home country relative to the host country.

Very important is further the institutional context. For example, labor markets in Western economies are strongly institutionalized. An inflow of labor will not, at least in the medium run, reduce wages sufficiently so that an new equilibrium situation can be achieved. This may occur in the long run, but the social and economic short

[13]Hicks (1932, p.76) stated that "...differences in net economic advantages, chiefly differences in wages, are the main causes of migration". Sjaastad (1962) considers earnings and costs of residence in the immigration- and emigration location over the life cycle of the potential migrant. An individual is then likely to migrate when the present value of this decision is positive. It will further migrate to that destination for which the present value becomes largest. Based on this motive, Berninghaus and Seifert-Vogt (1987, 1988) model the migrant's decision problem under incomplete information.

run consequences may be such that the long run implications become irrelevant. Especially the short run consequences of migration are often of utmost interest and political relevance. In the short run, heavy immigration may, or may not create unemployment. To become unemployed is the most threatening aspect of labor migration for the work force of the immigration country. This fear is it what makes the native work force very sensitive to ideological and racist arguments. That an inflow of migrants generates unemployment is often used as a political argument to reduce or to stop migration by legal regulations. Whether, and to which extend migration really creates unemployment is one important question to be answered by the economist. For the analysis of these short run consequences of migration, a conventional neoclassical equilibrium model with perfectly flexible factor prices as a tool of analysis does not give too much insight into what are the short run consequences. An appropriate economic model should therefore explicitly consider the labor market and allow for wage rigidities.

Furthermore, one should always consider the legal context. Legal regulations do often restrict the choice set of a migrant worker. Especially when working with empirical data, the analyst should be aware of the restrictions under which the data was generated. The legal context further defines which migration is legal and which migration is illegal.[14] The consequences of illegal migration are often considerably different from those of legal migration. Illegal migrants can usually not claim any benefit support, they do not have any labor market rights and they can not demand minimum wages. They are consequently a very cheap and flexible source of labor. Their own situation in the host country is by far more risky than that of legal migrants. Their economic behavior in the host country is therefore likely to be different from that of legal migrants.

The above features of migration are timeless. However, migration has also a time dimension. The dynamic aspect of migration is extremely important for the analysis of the consequences of migration, and it is an issue of major interest in the following chapters. Migration may simply be classified according to whether it is temporary or permanent. Temporary migration may again be distinguished between a variety of sub categories.

A rough classification is provided in figure 1. Three main groups of migration are categorized: *temporary migration*, *permanent migration* and *political migration*.[15]

[14]Illegal Immigration and the consequences for the host country are treated by Ethier (1986) and Chiswick (1988).

[15]The term *temporary* is used here from the perspective of the host country: a migrant is a temporary migrant, even if he leaves the home country permanently, as long as he remains only temporarily in a given host country.

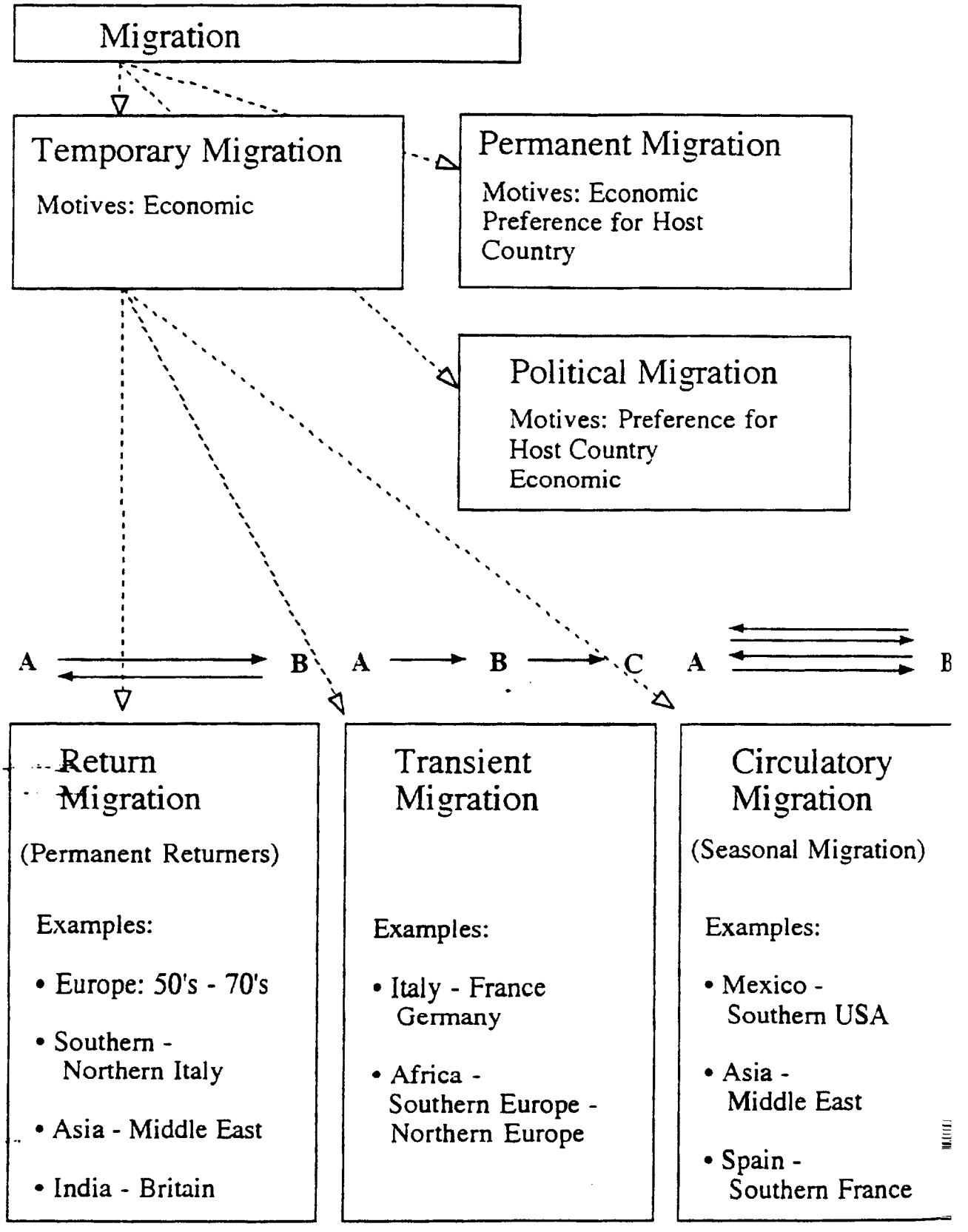
Migration
Temporary Migration
Motives: Economic
Permanent Migration
Motives: Economic
Preference for Host
Country
Political Migration
Motives: Preference for
Host Country
Economic
A
B
A
B
C
A
B
Return
Migration
(Permanent Returners)
Examples:
• Europe: 50's - 70's
• Southern -
Northern Italy
• Asia - Middle East
• India - Britain
Transient
Migration
Examples:
• Italy - France
Germany
• Africa -
Southern Europe -
Northern Europe
Circulatory
Migration
(Seasonal Migration)
Examples:
• Mexico -
Southern USA
• Asia -
Middle East
• Spain -
Southern France

Figure 1.1

The motives for temporary migration are primarily of economic nature. Permanent migrants have usually likewise economic motives, but also a preference to live in the host country. Political migrants have strong preferences to live in the host country. This is normally a result of political or ethnical persecution in the home country, or discrimination because of political or ethnical reasons. Economic motives play a minor role in the case of political migration.[16]

Temporary migration may again be sub classified. One important type of temporary migration is *circulatory migration*. With circulatory migration, migrant workers move frequently between the host- and the source country. They only stay for a short period in the target country, for example for the harvest season. Circulatory migration is usually induced by a seasonal excess demand for labor in the immigration country. This temporary excess demand for labor can not be supplied by the native work force at adequate prices. Circulatory migration is often illegal (Mexico-Southern States of the US),[17] and it is sometimes crucial for the competitiveness of the respective industry (frequently in the agricultural sector) in the host country.

Transient migration describes a situation where migrants move between different host countries without necessarily returning home. An example for transient migration may be guest worker migration in Europe in the 60's and 70's, where migrants from Southern European countries moved between Northern European countries. Transient migration classifies also a very actual migration phenomenon. Many African or Asian migrants enter Europe through Italy, Spain or Portugal and then start to move towards Northern countries like Germany or even Sweden.

Return migration has been by far the most important type of migration in Europe over the last decades, and it may become again very important in the near future. Return migration is the type of migration one has usually in mind when referring to migration as being temporary. It describes a situation where migrants return to their country of origin after a significant period abroad. A return migrant migrates because of mainly economic motives, like high wage differentials between home- and host countries, or high unemployment in the home country. He has, however, at least initially, a strong preference to live in his home country.

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[16]This third category seems artificial - political migrants are either permanent or temporary migrants. However, different from the other two groups, whose status is either determined by their own decision or by the regulations of the host country, the status of political migrants is conditioned on the situation in the home country.

[17]On legal and illegal migration between Mexico and the US, see Chiswick (1988) and Reynolds and McCleery (1985, 1988).

Table 1.1: Return Migration

TYPE	EX ANTE	EX POST	CLASSIFICATION
I	Migration with Intended Return	Return	RETURN MIGRATION
II	Migration with Intended Return	No Return	
III	Migration with no Intention to Return	Return	MIGRATION WITH PERMANENT CHARACTER
IV	Migration with no Intention to Return	No Return	

1.3 Return Migration

This research will mainly be concerned with return migration. Before proceeding, it seems reasonable to specify the notion return migration in the way it will be used in the following chapters. A return migrant will be defined as a migrant who initially and over some period of his stay abroad has the firm intention to return home. Should the migrant in the end decide to stay permanently, he will still be referred to as a return migrant. The reason to define return migration in this way is that economic behavior and decisions of migrants do not depend on future realizations, but rather on current intentions. Intentions of return are likely to have a strong impact on the migrant's behavior in the host country and, as a consequence, on the economies of host- and home country. The definition for return migration as it will be used here is oriented on ex-ante intentions, not on ex-post realizations.

Table 1.3 provides a simple categorization. It may be noted that a migrant who initially intends to stay permanently abroad, but decides at some point of his migration history to return home would not correspond to the above definition of a return migrant.

1.3.1 Return Migration - Some Stylized Facts

Return migration was the prevailing type of migration into central Europe between the late 50's and the early 70's. Labor requirements and high wages of Western Europe's industrialized economies and poverty as well as unemployment in Southern European countries and in Turkey induced an immigration boom into the center of Europe. By 1973, this migration process had accumulated an estimated stock of 10 million

migrants from the periphery into the core of Europe (King (1985), p.38). Since then, the trend has reversed, partly due to the oil-induced recession in the immigration countries and partly encouraged by positive economic developments in the countries of origin. And, of course, due to the essentially temporary character of this type of migration which induced migrants to return to their home countries. Return migration is likely to become again important for Europe in the near future, and this time between the Eastern European countries and the industrialized countries of Western Europe. Return migration is not only a European phenomenon. It is also the major form of migration between Asian countries like Thailand[18] and countries of the Middle East.

As a general feature, the target countries of return migration exhibit an excess demand for labor in at least some segments of the labor market. This labor can not be supplied by the local work force either in the quantity requested, or at adequate prices, or both. The emigration countries are generally characterized by an excess supply of labor and/or wage rates that are far below those offered in the target countries.

Migration between source- and target country is generally meant and wished to be temporary by both the governments of the emigration- and the immigration country, and, at least initially, by the migrant himself. Emigration countries often consider this form of migration as a relief from the pressure of excess labor supply in their labor markets. Furthermore, the temporary stay of the migrant worker abroad is regarded by the emigration country as a means to acquire human capital (by schooling and training of migrants in the target counties) that is needed for the future construction of own industries (Mehrländer (1980), p.82). Savings and remittances of migrants further provide development support for the migrant's home region in the emigration country. Additionally, they often provide a major balance of payments support for the labor exporting country.[19]

The immigration countries hope to bridge a temporary shortage in labor supply by temporary inflows of migrant labor. Furthermore, return migration helps to avoid the implementation of costly labor-saving technologies. The migrant himself usually wishes to accumulate a stock of savings and to return after a significant number of years abroad. The accumulation of a saving target is a common feature of return

[18]For a survey on return migration between Thailand and countries of the Middle East, see Pitayanon (1986).

[19]For instance, Robinson (1986) reports that remittances of Pakistanis to the Middle East finance some 86% of Pakistan's trade deficit. Kumcu (1989) emphasizes the role of remittances and savings as a major balance of payments support for countries like Turkey and Yugoslavia. Hiemenz and Schatz (1979) report that in 1973, transfers of earnings of foreign workers in Germany to Turkey and Yugoslavia were 4,700 Million DM, which amounted to over twice the total foreign exchange obtained through exports of goods from those countries to the host country.

migration. Savings are often used to buy houses in the home countries or to establish small businesses upon return.[20] Piore (1979, p.54) emphasizes the accumulation of savings as a special feature of temporary migration. Paine (1974, p.101) considers the saving of some target amount as the chief purpose of return migrants.

Many immigration countries only allow for temporary stays and issue temporary work permits (e.g. Switzerland, countries of the Middle East). Other countries do not impose such rigorous restrictions on the migrant's duration of stay, or they are not allowed to do so by international agreements. For instance, member states of the European Community cannot simply urge migrant workers from other member states to return home. Sometimes special agreements between emigration- and immigration countries have been set up that limit the possibilities for restrictions on the migrant's duration of stay. Furthermore, legal regulations may foresee a permanent working permit when the migrant has been in the country for a certain number of years. As a consequence, the return of these migrants is often to a large extent determined by their own choice. The government of the host country may provide some incentives to induce migrants to return,[21] but it often can not force them to do so.

There is ample evidence that a considerable part of return migrants do in fact return to their home countries.[22] Nevertheless, in times of economic downturn and rising rates of unemployment, migrants are often considered to contribute to job shortages in the host countries. Therefore, these migrants become therefore a matter of heated political discussion. In these situations, repatriation projects like the one mentioned above are launched.

1.3.2 Interest of the Thesis

This research is mainly concerned with the decision processes of return migrants. A thorough understanding of how migrant workers meet their decisions, and of what influences their decisive behavior may allow design of policies that induce migrants to

[20] For example, Gmelch (1980, p.150) reports that in Ireland 30% of returnee households had established small businesses.

[21] For example, the German government instituted measures like the Return Migration Assistance Act of 1983, which was directed at migrants from non-European Community countries. The aim of this repatriation assistance (*Rückkehrhilfe*), which was paid to those migrants who agreed to return to their home countries permanently, was to achieve a large reduction in the foreign population.

[22] Böhning (1984, p.147) estimates that "more than two thirds of the foreign workers admitted to the Federal Republic [of Germany], and more than four fifth in the case of Switzerland, have returned". Glytsos (1988) reports that from the 1 million Greeks migrating to West Germany between 1960 and 1984, 85% gradually returned home.

behave in a way so as to correspond to the intentions of policy makers. This may then be achieved by a sophisticated system of incentives which indirectly determine migrants decisions, rather than by a strict and direct framework of laws and regulations.

The following chapters will try to shed some light on issues that seem to be important in the context of return migration. The questions asked are of the following kind. When considering the situation of a return migrant in the host country, what determines his investment into human capital, and, as a consequence, his earnings position in the foreign labor market? Is there any empirical evidence that, over the migration history, the earnings position of return migrants, relative to native workers, develops differently from the earnings position of permanent migrants? What impact has the intended duration of stay on the migrant's earnings profile? What effect have differences in individual characteristics and intentions on the earnings position of migrant workers? Are these differences measurable, and what are the implications for empirical analysis?

Furthermore, how do return migrants meet their migration decisions, what determines their return decisions, their savings decisions and their savings target? Is their any impact of the intended duration of stay on the migrant's savings behavior? Will the introduction of uncertainty change the implications of a deterministic framework? Is it possible to isolate the factors which determine the intended return of a migrant worker? Is there empirical evidence of some observed variables having a significant impact on return decisions, and are the empirical results consistent with the implications of the theory?

The remaining part of this research will try to give answers to these questions. The next section will provide a general outline of the following chapters. In the analysis, the more general term *temporary migration* is sometimes used instead of *return migration*. It should be noted that the chapters were written as independent papers and are therefore self-explaining. However, the introductory parts may therefore sometimes be repetitive.

1.4 General Outline

When new immigrants enter the labor market of the host country, their earnings are initially considerably lower than those of comparable native workers. However, over time migrants acquire skills and assimilate to the foreign labor market conditions. A variety of recent empirical studiesinvestigate whether the assimilation to the foreign labor market is sufficiently strong so as to close the initial earnings gap between migrant

workers and the native population.

Using data for the USA, Canada and Australia, the common conclusion of these studies is that the initial earnings gap between migrants and natives decreases over time. In some cases, earnings profiles of migrants even cross over with those of comparable native workers. The main explanations for the rapid decrease of the earnings gap between migrants and natives is a strong incentive of migrants to invest into human capital which is specific to the needs of the labor market of the host country. The cross-over of migrants' earnings profiles with those of native workers, as observed in some studies, is usually explained by the selective character of migration. Migrants are drawn from the upper part of the ability distribution of the home country population. Under the assumption that abilities are similarly distributed in home country and host country, the average migrant worker should consequently be more able than the average native worker.

A common feature of the kind of migration examined in these studies is that it is permanent rather than temporary. Chapter 2 will reconsider the earnings adjustment of migrant workers when migration is mainly of a temporary character. In particular, it will be shown that in the case of temporary migration the optimal investment into country specific human capital should be lower than in the case of permanent migration. Investments may not be sufficient to allow migrants' earnings to catch up with those of native workers. Furthermore, it will be pointed out that migration is positively selective only under certain labor market conditions. These hypotheses will then be empirically tested, using data for return migrants in West Germany. The empirical findings support the hypotheses of low investment into human capital when migration is temporary. The results suggest a need to differentiate carefully between temporary and permanent migration when investigating migrant's earnings assimilation.

Chapter 3 develops a model that analyzes human capital investment and earnings patterns of target saving temporary migrants in a continuous time framework. The analysis will point out differences in investment- and earnings profiles which are due to differences in individual characteristics of migrant workers. The model predicts that earnings profiles of temporary migrants vary considerably due to differences in their saving targets, their ability level, their skill level upon arrival, their consumption pattern and their intentions after return to their home countries. The model provides a theoretical basis for the estimation of earnings profiles of temporary migrants.

Chapter 4 analyzes savings behavior and migration decisions of temporary migrants in a two-period model where the length of each period is a further choice variable. Special attention is given to the impact of a stochastic environment on the migrant's choice. The paper emphasizes two aspects which are likely to explain to some extent

the relatively high savings of migrant workers: savings due to life cycle motives, and savings due to precautionary motives. Furthermore, the impact of uncertainty about future income on the migration decision as such and on the time the migrant wishes to stay in the host country is analyzed. The results show that the effect of uncertainty on the time the migrant intends to stay abroad is ambiguous. It depends not only in sign, but also in size on the utility structure of the migrant worker as well as on characteristics of the economies of host- and home country.

Chapter 5 analyzes return decisions of temporary migrants. A theoretical intertemporal model will be developed where the point of return to the home country is endogenous. Hypotheses implied by the theory are then empirically tested, using micro data on migrant workers to Germany. The empirical analysis follows two steps: first, the decision of the migrant whether or not to return is analyzed. Secondly, the length of expected duration of those who want to return is investigated. The empirical results are consistent with the implications of the theory.

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Chapter 2

Earnings Adjustment of Temporary Migrants

2.1 Introduction

In recent years the labor market adjustment of immigrants and the speed of the adjustment of their earnings to the level of respective native workers has been of growing interest in the economic literature. Following Chiswick's (1978) seminal article, a number of contributions applied some extended version of the human capital earnings function as developed by Mincer (1974) to cross-sectional as well as longitudinal data.[1] The general conclusion of these studies was that immigrants are doing surprisingly well in the American, Canadian and Australian labor market. The empirical results indicate that earnings of migrant workers, being initially lower, grow rapidly and, in some cases, overtake those of comparable native workers after no more than 10-15 years.[2] The steeper age-earnings profiles of migrant workers compared with native workers were usually explained by a stronger incentive to invest into human capital. The finding

[1]See, for example, Chiswick (1978), Tandon (1978), Long (1980), Borjas (1982, 1989), Chiswick and Miller (1985), and Meng (1987).

[2]Chiswick (1978) found that earnings of migrants in the American labor market exceed earnings of native-born men with same characteristics after 10-15 years. Analyzing earnings adjustments of migrants in the Canadian labor market, Meng (1987) calculated that the native-foreign earnings gap closes after 14 years. Borjas (1989) used a longitudinal data set on high-skilled workers for the US. He argued that cross-sectional results overestimate the positive assimilation of migrant workers because return migration may not be randomly distributed among migrants and the quality of migrant cohorts may deteriorate over time. However, his results support the general perception that immigrant earnings do catch up to those of native workers, although the rate of convergence is relatively slow and an overtaking of earnings does not take place for all cohorts.

that earnings of migrants exceed those of native workers after an adaptation period was explained by a higher level of labor market ability and work motivation (Chiswick 1978). One could accordingly draw the general conclusion that migrants succeed in compensating for their initial earnings disadvantage by considerable investment into country-specific human capital and, furthermore, that migrants are often a self-selected group, having a higher ability and motivation than the average native worker.

However, the kind of migration examined in the studies mentioned above was permanent rather than temporary. Moreover, the migrant was confronted with highly competitive labor markets, favoring selective migration. Therefore, the questions arise whether these results remain valid if migration is temporary and if labor is not only "pulled" by a favorable labor market situation in the host country, but also "pushed" by highly unfavorable conditions in the source country.

This chapter will try to answer these questions. Section 2 will present some theoretical considerations, pointing out that the two main hypotheses used to explain the favorable situation of migrants in the labor markets of the receiving countries, high investment incentives and positive selective migration, will not necessarily be true if temporary migration is considered. An example for the kind of migration for which the above hypotheses are not likely to hold would be the temporary migration from Southern Europe and Turkey to West Germany. Section 3 will then empirically examine the assimilation of temporary migrants to the labor market conditions in West Germany. The empirical findings support the hypotheses outlined in the theoretical section. The main conclusion is then that it is necessary to carefully differentiate between permanent and temporary migration if analyzing the earnings adjustment of migrant workers.

2.2 Some Theoretical Considerations

2.2.1 Country-Specific Human Capital Investment and the Duration of Stay

The empirical literature on the speed of adjustment of immigrants to the labor market conditions of the country of immigration takes as a point of departure the human capital earnings function, as initiated by Becker and Chiswick (1966) and further developed by Mincer (1974). According to Mincer, it should be assumed that after leaving school the worker continues to devote a certain amount of his resources to furthering skills or acquiring job related knowledge. Measured earnings or net earnings are then the

difference between the worker's earnings potential, or gross earnings, and the cost of investment into human capital in that period.[3]

In the case of migrants, however, a second factor has to be considered. Since the human capital the migrant acquired in his home country is only partially transferable to the foreign labor market, the migrant, once being in the receiving country, will additionally adopt host-country specific human capital.

Accordingly, measured earnings of the migrant at time t may be expressed by the following expression:

$$lnY_{it} = lnE_{it} + ln(1 - k_{it} - \mu_{it}) \tag{2.1}$$

Y_{it} are measured earnings and E_{it} is the migrant's gross earnings potential, both at time t. i is an index for the i^{th} individual. k_{it} and μ_{it} are the fractions of the earnings potential devoted to human capital investment, either by furthering human capital or by acquiring country-specific skills, respectively. Assume that the fraction of the earnings capacity which is invested decline linearly during the working life and the duration of stay:[4]

$$k_{it} = k_{i0}\left(1 - \frac{j}{T_i}\right); \qquad \mu_{it} = \mu_{i0}\left(1 - \frac{h}{\theta_i}\right) \tag{2.2}$$

where k_{i0} and μ_{i0} are the ratios of post-school investment to potential earnings after leaving school and of host-country specific human capital investment to potential earnings upon entering the host-country, respectively. T_i is the length of working life and θ_i the amount of years the migrant worker intends to stay in the host country. j and h are time indices. Either investment ceases if $j = T_i$ or $h = \theta_i$.

The gross earnings E_{it} of a migrant in a certain period t depend on the earnings potential he accumulated before and after migration. In logarithmic form and using a continuous notation, E_{it} can be expressed as follows:

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[3]The cost of investment into human capital is best understood in terms of opportunity costs. If the "full income" of a worker is equal to the time he is able and willing to devote to working activities, weighted with the wage rate that corresponds to the worker's stock of human capital, then the measured income would equal the full income minus the value of time spent for investment activities.

[4]The linearity assumption is only an approximation of the optimal path of investment. The paths of μ_{it} and k_{it} can be thought of as the solution of an optimal control problem. For an extensive treatment of human capital investment of temporary migrants in an optimal control framework, see chapter 3.

$$lnE_{it} = lnE_i^0 + r_i^s S_i + r_i \int_0^{\tau_i} k_{it}\, dt + \varrho_i \int_0^{I_i} \mu_{it}\, dt \tag{2.3}$$

E_i^0 are gross earnings without any investment into human capital, S_i are years of schooling, τ_i is the total time of working experience and I_i is the time of residence of the migrant in the host country. r_i^S, r_i and ρ_i are the rates of return on investment into schooling, human capital, and investment into host country-specific human capital, respectively.

Inserting (2.1) and (2.2) into (2.3), solving the integrals and rearranging terms results in the following expression:

$$lnY_{it} = lnE_i^0 + ln(1 - k_{it} - \mu_{it}) + r_i^s S_i + r_i k_{i0} \tau_i - \frac{r_i k_{i0}}{2T_i} \tau_i^2 + \varrho_i \mu_{i0} I_i - \frac{\varrho_i \mu_{i0}}{2\theta_i} I_i^2 \tag{2.4}$$

Assuming the values of k_0, μ_0, r_s, r and ρ as constant among individuals, (2.4) indicates that differences in migrants' earnings are explained by different schooling backgrounds S_i and different lengths of working experience τ_i as well as varying durations of residence I_i in the host country. Furthermore, the theoretical derivation above suggests that the form of the investment profile of migrant workers and thus their earnings depends on the migrants expected total duration of stay, θ. This variable is neglected in all studies that investigate the assimilation of the earnings of migrant workers. In the case of permanent migration, θ may not help to explain differences among migrants' earnings. However, if θ varies considerably among individual migrants as it is the case with temporary migration, this variable may explain a significant part of earnings differences among migrant workers. Equation (2.4) indicates that, everything else being equal, the longer the migrant expects to stay in the host country, the less concave is his earnings profile. Therefore, the slope of earnings profiles may vary among otherwise identical temporary migrants if they have different expectations about how long to stay in the host country. Furthermore, since the migration history of the average temporary migrant is shorter than that of a permanent migrant, the above considerations seem to indicate that temporary migrants' earnings profiles are flatter than those of permanent migrants.

2.2.2 Selective Migration

The usual explanation for the empirical findings that migrant's earnings do not only adapt, but even overcome those of native workers is that migrants have, on average, higher innate labor market abilities than native workers. Arguing that the rate of

return to the migration decision is higher for a high-ability person than for a low-ability person, migration is self-selective.

The underlying assumption of the selective migration hypothesis as presented by Chiswick (1978, 1986) is that migrants are fully employed in both labor markets. If, however, the labor market of the emigration country is characterized by high unemployment that affects low-ability workers to a higher extent than high-ability workers, and if in the immigration country prevails an excess demand for labor, migration may even be selective in a negative sense.

This can easily be shown by reconsidering and extending Chiswick's theoretical argument of positive selective migration. Under the simplifying assumptions that earnings do not vary with experience, work life is long and migration costs are incurred only in the initial period, the rate of return to the migration decision for a more able person is, according to Chiswick (1986), given by

$$r = \frac{(w^H - w^S)(1+k)}{(1+k)\,c^O + c^D} = \frac{w^H - w^S}{c^O + \frac{1}{1+k}c^D} \tag{2.5}$$

where w^H and w^S are earnings in the host- and the source country, respectively, c^O are opportunity (time) costs and c^D direct costs of migration. (2.5) assumes that a more able person has earnings $k\%$ higher in both countries than a low able person. Since c^O are the time costs of migration, these costs increase with the ability level. It is obvious from (2.5), that, for $c^D > 0$, the rate of return is higher for the person with a higher ability level. Chiswick then concludes that the incentive to migrate is higher for high-ability workers. If abilities are similarly distributed among countries, immigrants will consequently have, on average, higher level of abilities than native workers. The selection process will be more intense the larger the direct costs of migration, c^D.

Chiswick's argument, however, is only true if certain labor market conditions are fulfilled. Assume an excess demand for labor in the host country and an excess supply for labor in the source country. In the case of temporary migration, host- and source country are often characterized by such labor market situations. Migration is often induced by a temporary excess demand for unskilled or semiskilled labor in the host country. The labor attracted stems from countries with significantly poorer economic conditions and, very often, an excess supply for labor in the low-skilled labor market.

Assume further that in the source country a high ability worker will more easily find a job than a low ability worker. Let k correspond to the deviation from the average ability level in the country of emigration and let $p(k)$ be the probability that a worker with level k is employed in the source country, with $p'(k) > 0$. b denotes

an unemployment benefit in the source country, with $b < w^S$. Adopting Chiswick's notation, the rate of return on the migration decision to a worker with level k can then be written as:[5]

$$r = \frac{w^H - [w^S p(k) + (1 - p(k))b]}{c^0 + \frac{1}{1+k}c^D} \tag{2.6}$$

The impact of a rise in k is now ambiguous: beside the positive effect on r, as explained above, a higher k will increase labor market opportunities of the potential migrant in his home country and, accordingly, decrease r. Therefore, for some probability distribution $p(k)$, some ability distribution and some set of values for earnings, costs and unemployment benefits the rate of return could well be highest at very low ability levels.[6] In that case, it would be more profitable for the less able worker to migrate: migration would accordingly be negatively rather than positively selective.

Although the arguments are extremely simple, the above considerations make clear that the kind of the selection process taking place strongly depends on the economic situation and the labor market conditions in both, the host- and the source country. In terms of the above analysis, migration will tend to be negative selective if unemployment benefits in the home country and the direct cost of migration are low, if there is an excess supply of labor in the home country while there is full employment in the host country and if the probability of being unemployed is higher for those with lower levels of probability.[7]

To summarize, the above considerations suggest that earnings profiles of temporary migrants are flatter than those of permanent migrants, resulting from a shorter pay-off period for any country-specific human capital investment. Furthermore, the generally assumed positive selection process is found to be strongly dependent on the

[5]Since c^O are time costs of migration, they will as well depend on $p(k)$. Assuming c^O as constant does not change the intuition of the argument and simplifies matters.

[6]Let the derivation of abilities from the average ability level in the source country be normally distributed around the mean $\bar{k} = 0$. Let σ be the variance, with $\sigma = 0.5$. Accordingly, $f(k) \sim N(0, 0.5)$. Furthermore, let the probability that a person with relative ability level k is employed be equal to the cumulative distribution: $p(k) = F(k)$. If $b = 0$ and, for instance, $w^H = 10$, $w^S = 5$, $c^0 = 2$ and $c^D = 1$, the rate of return will be highest for $k = -0.2$. For similar distributions of abilities in the host- and the home country, migration would tend to be negatively selective.

[7]A further analysis of the selective migration hypothesis is presented by Borjas (1987). Using a theoretical framework set up by Roy (1951), he shows that the selection bias depends on the dispersion of earnings in the home- and in the host country and on the correlation between the disturbances affecting both labor markets. According to his analysis, a necessary condition for a positive selection is that the correlation between disturbances affecting both labor markets is sufficiently high and that income is more dispersed in the host country than in the home country.

economic situations in host- and source country. In the case of temporary migration economic circumstances may favor non-selective or even negative selective migration rather than positive selective migration.[8]

2.2.3 Migration to West Germany - Some Stylized Facts

Looking more closely at the history of temporary migration to West Germany, one finds that, according to the theoretical considerations above, both arguments that are used to explain the strong position of migrants in the Australian, Canadian and US-American labor market are not likely to hold for temporary migrants in West-Germany.

Post-war labor immigration into West Germany started in the mid 50's and accelerated rapidly until 1973. The percentage of foreigners employed in the labor force increased from 0.6% in 1957 to 11.2% in 1973, the highest percentage of foreign workers ever employed in West Germany, and declined thereafter.[9] This heavy immigration of laborers mainly from Southern European countries and from Turkey was caused by the rapid economic development in West Germany after the second world war and the resulting growing excess demand for labor. It was supported by high unemployment rates and low per capita incomes in the countries of origin. The growing inflow of foreign workers into the German labor market was accompanied by a number of measures regulating legal, social and labor market conditions. The fear of the unions that foreign labor might be used by employers to keep wages down, the interest of employers in encouraging recruitment of foreign workers, as well as the effort of source country governments to sustain equal rights for their citizens in the host countries were largely responsible for a number of agreements that virtually accorded equal treatment of migrants in the German labor market and within the social security system. Furthermore, in the 60's recruitment agreements were concluded between Germany and all the main source countries which considerably facilitated migration for the worker by guaranteeing him a one year contract upon arrival, accommodation and payment of travel expenses. Moreover, he could not be dismissed during the first year of residence.[10] Recruitment activities stopped in 1973, the turning point of the strong economic boom in Germany.

Accordingly, the situation of temporary migrants coming to Germany was charac-

[8]Note an important difference between the two arguments that favor a lower earnings pattern: While the level of ability imposes a restriction on the migrant to relatively improve his earnings position, low investments as a result of a short expected migration history are a free-choice decision.

[9]Bundesanstalt für Arbeit, Arbeitsstatistik 1974

[10]Mehrländer (1980), pp. 81, 82

terized by low costs of migration and high rates of return resulting from the considerable economic differences between most source countries and the host country. Emigration may have been especially appealing to those who would have had difficulties to find a job in the home country. In addition, the duration of stay was expected to be temporary both by the governments concerned and by the guest worker himself. This may result in a lower incentive to invest into country-specific human capital as is the case with permanent migration. Consequently, one would expect to find migration to West-Germany to be less positively selective and the effort of the migrant to invest into country-specific human capital to be low.

In what follows, earnings profiles of temporary migrants in West Germany will be estimated. The main concern will be to test whether profiles differ from those found for permanent migrants in the labor markets of Australia, Canada and the United States. To test the hypothesis that the duration of stay has a positive impact on country specific human capital investment, additional tests are carried out, using interview data on the expected length of stay of the migrant worker.

2.3 An Empirical Analysis

2.3.1 Data and Sample Characteristics

The empirical analysis below uses as a data base the first wave of the German socio-economic panel, collected in 1984. The panel is organized on a household base. Besides asking about household specific characteristics, all people above 16 years were personally interviewed. The first wave consists of 6000 households which can be subdivided into two subsamples, according to the nationality of the head of the household. The subsample with a German household head comprises 4500 households, whilst that with a household head of Turkish, Spanish, Jugoslavian, Greek or Italian nationality comprises 1500 households.

The data used for this study is restricted to men of foreign and German nationality, above the age of 16 in 1984, who were full time employed at the time of the interview. Self-employed persons, persons who are enrolled in educational programs or who do an apprenticeship and state employees are excluded from the analysis. The latter group had to be removed from the sample since people with non German nationality are usually not allowed to become state employees. After removing all individuals who do not report their monthly gross earnings or their year of immigration (for foreigners), the final sample is reduced to 1876 persons with German nationality and 1083 persons

Table 2.1: Sample Characteristics of Native and Foreign males, 1984

	Natives		*Foreigners*	
	Mean	SD	Mean	SD
EARNINGS (DM)	**3334**	*1312*	**2670**	*661*
LOG OF EARNINGS	**8.05**	*0.35*	**7.86**	*0.25*
AGE	**39.90**	*11.28*	**39.60**	*10.68*
YEARS OF SCHOOLING[11]	**1.94**	*3.19*	**1.17**	*2.38*
YEARS OF TRAINING[a]	**3.08**	*2.52*	**1.32**	*2.35*
YEARS OF WORKING EXPERIENCE	**20.18**	*11.70*	**20.31**	*10.63*
MARRIED (%)	**75.94**	*43.34*	**85.33**	*35.40*
YEARS SINCE MIGRATION	*	*	**14.76**	*5.12*
LANGUAGE SATISFACTORY (%)	*	*	**39.76**	*48.96*
LANGUAGE GOOD OR VERY GOOD (%)	*	*	**43.08**	*49.54*
SAMPLE SIZE	1876		1084	

SOURCE: Socio-Economic Panel, wave 1, 1984.

with foreign nationality.

Table 2.1 compares some economic and socio-economic characteristics of German nationals and immigrants with foreign nationality. The average gross-earnings, reported as earnings in the month preceding the interview, are 20% higher for German nationals compared with foreign workers. This substantial absolute income difference might be partially explained by the different schooling- and training backgrounds of the two groups. From the sample information two different variables on the educational background can be extracted. Both refer to the level of education received after the age of 14.[12] The variable Schooling (SCH) measures the years spent in school, evening school or at university, while the variable Training (TRAIN) measures the years of job-specific education and apprenticeship. The average amount of years of both forms of educational input is higher for natives than for foreign nationals. Both groups have approximately the same average age (AGE) and working experience (EXP), with working experience measured as the amount of years a person was full time employed. A higher percentage of foreign nationals in the sample is married. A relatively high percentage

[12]The empirical analysis below therefore assumes an equal schooling background for all persons before the age of 15. A further differentiation of education and schooling was not possible since the data had to be constructed using a biographical scheme that lists life activities after the age of 14.

Table 2.2: Intended Length of Stay and Total Length of Stay, Foreign Males, 1984

Interval (in years)	≤ 1	$1 < x \leq 5$	$5 < x \leq 10$	$10 < x \leq 15$	$15 < x \leq 20$	$20 < x \leq 30$	> 30
YSM (in %)	0.31	5.33	8.88	49.21	20.68	15.56	0.00
ISTAY (in%)	6.47	31.97	21.94	4.49	3.23	0.63	31.26[a]
TOTSTAY (in%)	0.00	0.31	1.88	12.23	20.48	26.57	38.55

SOURCE: Socio-Economic Panel, wave 1, 1984. Sample size: 957 observations.

[a]99% of this number intend to stay forever.

of migrant workers claimed to have at least a satisfactory knowledge of the German language, even though none of the countries of origin uses German as a main language. The average amount of years since migration (YSM) is fairly high, indicating that most of the migrants immigrated before 1973, the year when recruitment activities stopped.

Subdivided into 7 time intervals, Table 2.2 reports statistics on the percentage of migrants that fall into the respective sub category on the years they have already spent in Germany, YSM, the length of time they intend to further remain in Germany, ISTAY, and the total length of stay, TOTSTAY. Specifically, the numbers for the construction of the variable ISTAY are based on interviews which asked foreign nationals how long they further expect to stay in Germany. Possible answers were *forever* or a specific number of years.[13] TOTSTAY is then calculated by simply adding the amount of years the migrant intends to remain in the host country and the number of years since migration.

The first row of table 2.2 indicates that 85% of the migrant population in the sample has been in Germany for more than 10 years. The numbers in the second row reveal that nearly one third of the migrant population intends to stay more than 30 years or forever. However, more than 55% of the migrants intend to return to their home countries within the next ten years. The numbers reveal, furthermore, that of the migrant population living in Germany less than one third intends to change the temporary status into a permanent status, even though the intended total length of stay of more than 95% of migrant workers is longer than 10 years. One could expect that from those who do want to return to their home countries a high percentage will retire in Germany and return after retirement. This is, however, not the case. From those who do not intend to stay forever in Germany (69% of the migrant subsample), only 2.3% want to return after the age of 64.[14] This implies that the vast majority of migrants intends to either try to find employment in their home country, live on

[13]Due to missing values in these variables, the sample reduces to 957 observations.

[14]8.8% will be older than 60 at the point of expected return.

savings or become self-employed after return.

2.3.2 A Comparative Analysis of Earnings of German and Foreign Nationals

Different empirical specifications of equation (2.4) will be used for estimation, using data on natives, on foreign nationals and a pooled data set. In this section the hypothesis will be tested whether, as found for other countries, the earnings of migrant workers in Germany do catch up with those of German nationals. The assumption of previous studies will be adopted that, even if two otherwise identical migrants differ in their expected duration of stay, their experience-earnings profiles are the same, i.e. $\theta_i = \theta \; \forall i$. This restriction will then be relaxed in section 2.3.3.

Table 2.3 reports OLS estimation results using data on German natives (column (1)) and a pooled data set of both, foreign nationals and natives (column (2)-(6)).[15] The coefficients presented in column (1) emerge from a regression of the natural logarithm of monthly earnings on the exogenous variables labor market experience (EXP), labor market experience squared (EXPSQ), marital status (MARRIED), years of schooling (SCH) and job-specific education and apprenticeship (TRAIN). Results in columns (2) - (6) are produced by pooling the two subsamples of natives and migrants. Regression equations in columns (2) and (3) are extended by a dummy variable (FOR) that is 1 for foreign nationals, and by the variables years since migration and years since migration squared, (YSM) and (YSMSQ), respectively. These variables are zero for natives. The equations presented in column (4) -(6) additionally allow for varying parameters of the experience variables and the schooling variables between natives and foreign nationals. Furthermore, dummy variables on language abilities are introduced, where L2 stands for satisfactory and L3 for good or very good knowledge of the German language.

The results using the native subsample (column (1)) are quite similar to those found in other countries. All coefficients have the expected sign and are significantly different from zero. Evaluated at 5 years of experience, an additional year of being in the labor force increases earnings of natives by 2.97%. After 15 years of working experience the positive impact of an additional year of experience has been reduced to 1.5%. The impact of schooling and job-specific education on earnings of natives are

[15] A χ^2 test as suggested by Breusch and Pagan (1980) revealed that all estimations suffer from heteroscedasticity. The appropriate estimators for the variances of the parameter estimates are obtained by using a method as suggested by White (1980). White's estimate of the covariance matrix is consistent and allows to draw inferences from OLS results without necessarily specifying the form of heteroscedasticity.

Table 2.3: Regression Analysis of Earnings of Foreign and German Nationals (Dependent Variable: Natural Logarithm of Monthly Earnings)

VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)
CONSTANT	**7.43**	**7.51**	**7.51**	**7.48**	**7.43**	**7.43**
	(264.31)	(329.63)	(320.71)	(279.23)	(264.68)	(264.73)
EXP	**0.037**	**0.032**	**0.032**	**0.036**	**0.037**	**0.037**
	(13.18)	(16.02)	(15.58)	(13.42)	(13.96)	(13.93)
EXPSQ	**-0.00073**	**-0.00065**	**-0.00065**	**-0.00072**	**-0.00074**	**-0.00074**
	(-11.95)	(-14.68)	(-14.38)	(-12.01)	(-12.19)	(-12.18)
SCH	**0.050**	**0.041**	**0.040**	**0.040**	**0.050**	**0.050**
	(13.03)	(13.36)	(13.22)	(13.05)	(13.08)	(13.07)
TRAIN	**0.023**	**0.019**	**0.020**	**0.019**	**0.023**	**0.023**
	(6.88)	(8.18)	(8.04)	(8.10)	(6.95)	(6.94)
MARRIED	**0.138**	**0.129**	**0.129**	**0.127**	**0.125**	**0.127**
	(8.43)	(9.41)	(9.42)	(9.30)	(9.32)	(9.44)
FOR		**-0.152**	**-0.210**	**-0.165**	**-0.020**	**-0.065**
		(-13.68)	(-3.15)	(-2.35)	(-0.29)	(-0.89)
FOR*YSM			**0.0056**	**0.0134**	**0.0152**	**0.0149**
			(0.66)	(1.50)	(1.74)	(1.67)
FOR*YSMSQ			**-0.00010**	**-0.00029**	**-0.00027**	**-0.00029**
			(-0.39)	(-1.08)	(-1.02)	(-1.08)
FOR*EXP				**-0.011**	**-0.019**	**-0.019**
				(-2.79)	(-5.06)	(-4.99)
FOR*EXPSQ				**0.00022**	**0.00032**	**0.00034**
				(2.45)	(3.83)	(3.98)
FOR*SCH					**-0.040**	**-0.040**
					(-7.21)	(-7.36)
FOR*TRAIN					**-0.010**	**-0.010**
					(-2.06)	(-2.17)
FOR*L2						**0.040**
						(1.89)
FOR*L3						**0.067**
						(3.06)
ADJ. R^2	0.33	0.33	0.32	0.33	0.34	0.34
No. of Obs.	1876	2960	2960	2960	2960	2960

SOURCE: Socio-Economic Panel, wave 1, 1984. Note: t-ratios in parenthesis. Reported t-statistics are based on standard errors which are corrected for heteroscedasticity. Regression results presented in column (1) are generated using the data set on German nationals only. Results in column (2)-(6) are based on a pooled data set of natives and foreign nationals.

quite different. While an extra year of job-specific education raises income by 2.3%, the impact of an additional year of after-elementary schooling is considerably larger (5%). Married men have earnings 14% higher than non-married men.

Column (2) reports results emerging from using the pooled data set. The dummy variable for foreigners, FOR, is strongly significant. The coefficient indicates that the overall earnings difference between native and foreign workers, which was found to be 21% (table 2.2), reduces to 15% after controlling for different backgrounds of schooling and training. The poorer educational background of migrant workers is therefore responsible only for a small part of the earnings gap.

Coefficients for the variables YSM and YSMSQ (column (3)) have the expected sign, but are not significant.[16] These results seem to indicate that the duration of stay in the host country does not have a narrowing impact on the earnings gap between German nationals and migrant workers. However, allowing for varying parameters on the experience variable between the two groups slightly increases size and significance of the YSM-coefficient (see results in column (4)). Since a further year in the host country affects migrants' earnings via the years since migration variables as well as via the experience variables, the results in columns (4) and (5) indicate that the effect of a further year of residence, although improving the relative earnings difference of immigrants, is compensated by the considerably lower effect of the experience variable on immigrants earnings (FOR*EXP), as compared with the effect on natives earnings.

To gain further insight into the relative adjustment of migrants' earnings, estimation results from the two subsamples on native and foreign workers (column (1) in table 2.3 and 2.4, respectively) are used to calculate the percent earnings increase for an additional year of experience in the German labor market. According to table 2.1, migrants enter the German labor market after an average labor market experience in their home country of 5.5 years. Upon entering the host country, each additional year in the German labor market increases their earnings by $\delta \ln Y^M / \delta t = 0.030 - 0.0015\, t$ (calculations based on column (1), table 2.4). Measured likewise after 5.5 years of labor market experience, an additional year raises earnings of native workers by $\delta \ln Y^N / \delta t = 0.029 - 0.00146\, t$ (calculations are based on column 1, table 2.3). Both expressions are not substantially different. Evaluated at 5 years after entry into the German labor market (which corresponds to 10.5 years being in the labor force), an additional year increases migrant's earnings by 2.25%, while it increases earnings of a comparable native worker by 2.17%. After 10 years in Germany, or 15.5 years in the labor force, the respective numbers are 1.5% for migrants and 1.44% for natives.

[16]The null hypothesis of the coefficients of YSM and YSMSQ being jointly equal to zero could not be rejected at the 10% level of significance. The respective F-statistic is F(2, 2951) = 0.088.

Accordingly, there is no earnings crossover and virtually no narrowing impact of the duration of residence on the income gap between temporary migrants and German nationals as found in other empirical studies on migrants' earnings. Temporary migrants do not improve their relative earnings position in the German labor market.

Column (5) in table 2.3 reports results of an estimation that allows for varying coefficients of the educational variables between foreign and German nationals. A year of schooling or training affects earnings of migrants and native workers to a different extend. The effect of an additional year of schooling of foreign citizens on monthly earnings is significantly lower than for German nationals. The difference is considerable: while each year of schooling increases earnings of natives by 5%, it increases earnings of migrants by only 1%. The effect of a year of job-specific education and apprenticeship on earnings of migrants is likewise significantly lower than on earnings of native workers. An explanation for these results may be that migrants' schooling and job-specific education took mainly place in the home countries and is of small value in the German labor market. Finally, the results in column (6) indicate that a good or very good knowledge of the German language (L3) reduces the earnings differential considerably (6.7%).[17] Those with a satisfactory language ability (L2) have earnings which are 4% higher than those with a poor knowledge of the German language.

To summarize, the above results indicate that migrant workers in the German labor market do not improve their earnings position, relative to comparable native workers. These results are in contrast to the findings for other countries. The earnings gap between migrants and natives does not close over the whole migration history of the foreign worker.

The empirical findings may be explained by the hypotheses stated above: in terms of the human capital framework, temporary migrants in the German labor market may not invest amounts into host country specific human capital that are sufficient to catch up with native earnings. Furthermore, temporary migration to West Germany may be less selective as permanent migration to Australia, Canada or the United States.

2.3.3 Immigrant Earnings and the Expected Duration of Stay

Turning to an analysis of earnings of the subgroup of foreign nationals only, this section will be particularly concerned with the effect of the expected duration of stay on

[17]Note that coefficients on the language variables measure differential effects, both compared with a poor knowledge of the German language.

country-specific human capital investment. Results of an estimation specification as suggested by the theoretical analysis above as well as estimations using only the foreign subsample are given in table 2.4.

Comparing results in column (1) and (2) of table 2.3 with those in column (1) of table (4) reveals that the effect of both educational variables on migrant's earnings is found to be considerably smaller than on native's earnings, as was indicated by the results using the pooled sample. The variables schooling (SCH) and training (TRAIN) have approximately the same absolute effect on immigrants' earnings. This, however, contrasts to German nationals, where (SCH) has nearly a 50% higher impact on earnings than does (TRAIN). Being married (MARRIED) has a higher impact on earnings of native workers than on earnings of foreign workers.

The absolute effect of the duration of residence in Germany (YSM) on earnings is positive. Although migrant workers do virtually not improve their relative earnings position, the years of residence have a positive impact on their absolute earnings position (the variable YSM is significant at the 10% level). At the point of arrival, an additional year of residence increases earnings by 1.6%.[18] In column (2), dichotomous variables for language abilities are added to the estimation equation as additional indicators of assimilation. Migrants with a satisfactory knowledge of the German language have earnings 4% higher than their colleagues with poor language knowledge. This income difference increases to 6.5% if the latter group is compared with migrant workers with good or very good language knowledge. These differences in income due to language ability indicate that even in the low-skilled or semi-skilled labor market language ability is thought to be correlated with productivity by German employers. It may also indicate that workers with knowledge of the German language are more capable of acquiring and using specific labor market information and, consequently, obtain better-paid jobs.

As already indicated in section 2.2, the decision of an individual whether, and how much, to invest in human capital depends positively on the time horizon he considers as the pay-off period for a given investment.[19] In the case of migrants, and defining a linear investment function for country-specific human capital investment, the resulting earnings equation indicates that the coefficient on the quadratic term of residence in the host-county (YSMSQ) should differ among individuals according to their expected total

[18]Note that this only indicates that years of residence improve the absolute earnings position of migrant workers. This does not imply that it improves their earnings position relative to comparable native workers.

[19]For a thorough theoretical analysis of the impact of the duration of stay on migrant's investment into host country specific human capital, see chapter 3.

Table 2.4: Regression Analysis of Earnings of Foreign Nationals
(Dependent Variable: Natural Logarithm of Monthly Earnings)

VARIABLE	(1)	(2)	(3)	(4)
CONSTANT	**7.41**	**7.37**	**7.43**	**7.40**
	(113.24)	(109.30)	(178.47)	(94.73)
EXP	**0.019**	**0.019**	**0.022**	**0.022**
	(6.82)	(6.73)	(7.38)	(7.18)
EXPSQ	**-0.00044**	**-0.00042**	**-0.00047**	**-0.00048**
	(-7.38)	(-7.01)	(-7.53)	(-7.44)
SCH	**0.011**	**0.010**	**0.013**	**0.013**
	(2.71)	(2.58)	(3.15)	(3.17)
TRAIN	**0.013**	**0.013**	**0.016**	**0.016**
	(3.60)	(3.59)	(4.67)	(4.64)
MARRIED	**0.093**	**0.098**	**0.084**	**0.081**
	(4.06)	(4.30)	(3.17)	(3.09)
YSM	**0.016**	**0.016**	**0.012**	**0.011**
	(1.89)	(1.82)	(4.08)	(1.15)
YSMSQ	**-0.00031**	**-0.00033**		**-0.00016**
	(-1.19)	(-1.23)		(-0.52)
L2		**0.040**		
		(1.91)		
L3		**0.065**		
		(2.99)		
YSMSQ/TOT			**-0.0056**	
			(-2.05)	
TOT				**0.0010**
				(1.36)
ADJ. R^2	0.14	0.15	0.15	0.15
No. of Obs.	1084	1084	957	957

SOURCE: The Socio-Economic Panel, 1984.
Note: t-ratios in parenthesis. Reported t-statistics are based on standard errors which are corrected for heteroscedasticity

duration of stay (see equation (2.4)). However, this simple deterministic specification assumes that the migrant has upon arrival in the host country a firm idea for how long to stay, and that his planned duration will finally realize. But it is unlikely that migrants enter the host country with firm intentions about their duration of stay, and it is even more unlikely that duration intentions upon arrival will finally realize. During their migration history, migrants may frequently revise their intentions. Furthermore, intended durations are not necessarily strongly exogenous, but the migrant's earnings position may likewise influence these intentions.

The available data allow to reconstruct a total duration of stay which is based on intended durations in 1984 and the years of residence. This number may, of course, differ from what the migrant would have said upon arrival. However, despite these shortcomings, it seems worthwhile to use this data for a test on the hypothesis that earnings profiles differ among migrants with different expected durations of stay.

An empirical specification of the variable θ is therefore constructed along the following lines: when the migrant worker intends to return before reaching retirement age (which was assumed to be equal to 64), TOT is calculated as the sum of the expected total duration of stay and the years since migration. It is therefore equal to TOTSTAY above. When the migrant intends to either return after retirement age or to stay forever, and based on the assumption that after an active working life no earnings-effective country specific human capital investment will take place any more, TOT was constructed by adding to the years since migration the difference between 64 and the age of the migrant.

According to equation (4), the intended duration should have an impact on the degree of concavity of the earnings profile. This requires the estimation of a regression with varying coefficients on the variable YSMSQ. Estimation results are given in column (3) of table 2.4.[20] Coefficients on the two variables YSM and YSMSQ/TOT are strongly significant. The numbers indicate that a longer intended total duration of stay improves the migrant's earnings position. After five years of residence, an additional year in the country will increase migrants earnings by 0.64% if the expected total duration of stay is ten years. This number increases to 0.92% if the migrant intends to stay for 20 years and to 1.01% if he intends to stay for 30 years. The results therefore support the hypothesis, suggested by the above theoretical considerations, that in the case of temporary migration the amount of investment in country-specific human capital depends positively on the expected length of stay in the host country.

[20]Note that, due to missing values in the variables which indicate the future intentions of the migrant, the sample reduces to 957 observations.

Column (4) reports results when the variable TOT is introduced as and additional regressor. Although the coefficient estimate has the expected sign, it is not significant. Furthermore, the significance level of the variables YSM and YSMSQ decreases.

2.4 Summary and Conclusion

Empirical studies on earnings assimilation of permanent migrants to Australia, Canada and the United States have shown that the initial earnings gap between migrants and native workers steadily decreases over the time the migrant spends in the host country. The main explanations for the steeper earnings profiles of temporary migrants was that migrant workers have stronger incentives to invest into their human capital than natives. The findings that migrant earnings overtake those of natives after an adaptation period was explained with the selective character of migration.

In section 2.2 it was shown that, in a human capital framework, the size of investment of a migrant into human capital specific to the labor market requirements of the host country positively depends on his expected total length of stay. Consequently, temporary migrants should do worse in the foreign labor market than permanent migrants. Furthermore, reconsidering Chiswick's argument for positive selective migration, it was found that migration will be positively selective only if certain labor market conditions are fulfilled in both, host- and source countries. In the case of temporary migration, labor market conditions in both countries are often likely to be unfavorable to positive selection. This may reinforce the weak position of these migrants in the host country labor market.

To gain some further insight into earnings adjustments of temporary migrants, earnings of native workers and migrant workers were analyzed. The data used stems from the German socio-economic panel. Temporary migration to West Germany seems to exhibit both features that are contrary to a favorable relative earnings position in the labor market of the host country: the migration is thought to be temporary and economic conditions in both, host country and source countries during the migration period seem not to be supportive for a positive selection. The empirical results indicate that, unlike the findings for permanent migration to other countries, foreign workers in the German labor market receive lower wages than their native counterparts throughout their working history, other things being equal. There is no earnings-crossover between these two groups. The income gap between migrant workers and natives in the German labor market is not closing over the migrant's migration history. Using data on the expected length of stay in the host country, empirical findings support the

hypothesis that the total length of stay positively influences country-specific human capital investment and, therefore, earnings of migrants.

The results suggest that it is important to carefully differentiate between permanent and temporary migration when considering the assimilation of migrants in the foreign labor market.

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Chapter 3

Temporary Migration and the Investment into Human Capital

3.1 Introduction

The economic situation of migrant workers in the labor markets of the host countries became an issue of growing interest in the economic literature in recent years. A variety of studies empirically investigated the adjustment of earnings of immigrants to those of native workers.[1] The general finding for countries like Australia, Canada and the United States was that migrant workers do surprisingly well in the labor markets of the host countries. Being lower upon arrival, migrants earnings gradually adjust to those of native workers and, as found in some studies, even overcome those of natives.[2]

The first finding is explained in terms of the human capital framework: migrants have a high incentive to invest into human capital specific to the labor market of the host country. They accumulate human capital faster than native workers, resulting in relatively steeper earnings profiles. The cross-over of earnings of migrants with those of natives is explained with a higher innate ability and work motivation of migrants if compared with native workers. However, the generally favorable assimilation of permanent migrants in labor markets of Australia, Canada and the United States can not be generalized for all types of migration. Analyzing earnings profiles of temporary immigrants to West Germany, it was shown in chapter 2 that there is virtually no wage

[1] see, e.g. (Borjas (1985), (1987), (1989), Beggs and Chapman (1989), Chiswick (1978), Chiswick and Miller (1985), Carliner (1980), Long (1980) and Meng (1987).

[2] Chiswick (1978) reports that earnings of migrants in the American labor market exceed those of native workers after 10-15 years. Meng (1987) calculated that the earnings gap between natives and immigrants in the Canadian labor market closes after 14 years.

catch-up of migrants in the German labor market as was found for other countries. He explains his findings with the temporary character of the type of migration considered, having a flattening impact on earnings profiles.

It seems that the results of any empirical analysis on migrants earnings position depend strongly on the type of migration considered. Explanations of empirical findings need a more thorough theoretical foundation. A variety of questions arise that can only be answered in a theoretical framework. For instance, Chiswick's (1978) explains his findings of a wage cross-over with high incentives of migrants to invest in country specific human capital and higher ability levels. Do these two factors independently influence the migrants earnings path or are there interactions between the level of a migrant's ability and his incentive to invest into human capital? And is the hypothesis theoretically justified that a low transferability of skills has a steepening effect on migrants earnings profiles? Furthermore, the literature does not define what really creates an incentive to invest into human capital. The incentive to invest into human capital should relate to the value of any further unit of human capital. A rise in those variables that positively influence this value would accordingly provide a positive investment incentive. If measurable, an identification of these variables would allow for some statements about investment incentives of a given migrant population.

Turning to temporary migration, there is a variety of additional factors that should be considered if analyzing the migrant's earnings position. First of all, it has to be defined why workers do only temporarily migrate. Which factors determine the migrant's duration of stay and how does this influence his optimal investment into human capital? Different from existing models of human capital investment over an individual's life cycle,[3] the optimal decision of a temporary migrant on how much to invest into his human capital during his stay in the host country depends crucially on a variety of parameters that either do not have to be considered in life cycle models, like the value a worker attaches to the stock of human capital acquired when leaving the labor market, or may be assumed to be constant among individuals, like the total duration of the worker in the labor market considered.

This chapter will present a model to analyze the human capital investment and the path of earnings of temporary migrants who are "target savers": migrants who only intend to stay in the host country as long as it is necessary to accumulate a certain stock of savings and then return to their home countries.[4] The main concern of the

[3]see, e.g., Ben-Porath (1967), von Weizsäcker (1967), Haley (1973), Heckman (1976), Blinder and Weiss (1976) and Rosen (1976).

[4]There is ample evidence that migration from Southern- to Northern European countries over the last decades consists largely of target saving temporary migrants. Glytsos (1988) characterizes these

analysis will be to identify parameters that are responsible for differences in migrants earnings position and to investigate their impact on earnings profiles. The results will be illustrated by simulations. The analysis provides a systematic theoretical analysis of factors that may have an impact on the earnings situation of target saving temporary migrants. The model has a variety of implications for empirical work.

In particular, section 3.2 outlines the assumptions and the basic model and describes the optimization problem of the migrant. Section 3.3 considers only the period of positive investment into human capital production and analyzes the impact of differences in individual characteristics on investment- and earnings profiles. Section 3.4 investigates the occurrence and length of corner solutions, i.e., intervals with zero or full investment into human capital. Section 3.5 summarizes the main results and points out the consequences for empirical analysis.

3.2 Human Capital Investment and Target Saving Migrants

3.2.1 The Target Saving Migrant

Why does temporary migration occur at all? Why should a migrant want to return to his home country after having worked for some years in the host country? According to Hicks (1932), the decision to migrate is simply induced by a higher rate of return on a unit of human capital stock in the host country (*net economic advantages*). Conse-

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migrants as "...staying relatively short periods of time in the receiving country, accumulating considerable amounts of money, remitting part of it during their stay abroad and returning home with the rest". He reports that, from the one million Greeks emigrating to West Germany between 1960 and 1984, 85% returned gradually home. Remittances over this period amounted to about $ 4 billion. Based on a representative sample from 1972, the "Bundesanstalt für Arbeit" found out that guest workers to West Germany transferred between 30% and 45% of their disposable annual income to their home countries. Furthermore, a part of migrant households accumulated a considerable stock of savings in Germany. Depending on the nationality, only 15% - 25% had firmly decided to stay in West Germany (see "Monatsberichte der Deutschen Bundesbank", April 1974). Kumcu (1989) reports, using a survey conducted by the "Central Bank of the Republic of Turkey", that the marginal propensity to save of turkish households in West-Germany ranks between 0.21 and 0.48. Macmillan (1982) reports similar numbers concerning the saving behavior for migrants in other European countries. In an excellent and comprehensive survey on migration of Thai workers to countries of the Middle East Pitayanon (1986) reports that remittances of migrant workers are considerable and to a large proportion invested into savings. The temporary character of migration is implied by a contract system that allows the worker to stay only for a restricted period.

quently, once having migrated, why should the migrant deliberately return to his home country? An answer would be that the consumption of an equal bundle of goods will yield different levels of utility, according to whether consumption takes place in the host- or in the source country.[5] Although the value of the migrant's stock of human capital may be higher in the host country, he may rather enjoy to consume in the home- than in the host country. More technically, if the marginal utility of consuming a given bundle of goods is higher in the home- than in the host country, and if, on the other side, the rental rate on a given stock of human capital is higher in the host- than in the home country, then migration is likely to be temporary. The argument is simple: in an intertemporal context, each unit of time the migrant offers to the labor market of the host country will increase his lifetime wealth by more than if this unit of time is offered to the labor market of the home country. It therefore increases his lifetime consumption and lifetime utility. On the other side, each unit of time spend in the host country will enable the migrant to consume during this time in his home country. Since life is finite and the marginal utility of consuming a given flow of goods is higher in the source country, this will have a decreasing impact on lifetime utility. It is now intuitively obvious that there should be an optimal length of stay t^* in the host country.[6] Since marginal utility is lower, the migrant will consume relatively less in the home- than in the host country and, accordingly, accumulate a certain stock of savings. Before he migrates, he will have to optimally determine the size of savings to be accumulated, the length of stay and his consumption pattern.[7]

However, at the time of decision making, the migrant may not be fully informed about the labor market situation in the host country. Let the migrant assume, when solving his optimization problem, that he will not increase his stock of human capital once being in the host country. This seems not to be an unrealistic assumption: friends or returners may have informed him about the earnings he may expect, given his level of skills. Since he is not well informed about the foreign labor market, he may not be able to anticipate any possibility of an improvement of his earnings position by human capital investment and rather rely on his relatively certain information.

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[5]The utility gained by consuming a given bundle of goods may depend on the environment where consumption takes place, including friends and family.

[6]In this framework, a permanent migrant is either characterized by a higher or equal marginal utility of a given bundle of goods in the host- than in the source country or by a corner solution of his optimization problem: the optimal time to be spent in the home country happens to be at least equal to his lifetime.

[7]For a thorough treatment of the migrant's optimization problem determining the optimal length of stay, the stock of savings to be accumulated and the consumption rate in a simple theoretical framework, see Djajic and Milbourne (1988).

He now determines the length of stay simultaneously with his saving target and his consumption pattern. Upon arrival in the host country, he acquires full information about labor market conditions. He then reoptimizes, being restricted concerning his saving target, because, e.g. prior precommitments, but being flexible concerning the duration of stay. Given wages and prices, the migrant can now influence the length of stay by investments into human capital specific to the labor market requirements of the host country. He will do so by solving a new optimization problem, with the objective to minimize the time necessary to achieve a given saving target.

In what follows, this sub-optimization problem of the migrant will be developed and analyzed in detail.

3.2.2 The Basic Model

In the following analysis it will be assumed that at each point in time the migrant can choose between two activities: the production of human capital and the production of earnings. At any t, he will therefore allocate his time to either one or both of these purposes.[8] The larger the stock of human capital, the larger is the migrant's earnings potential, i.e. the earnings he would realize per unit of time rented to the market. Furthermore, an increase in the stock of human capital will, besides increasing the earnings potential per unit of time offered to the market, increase the productivity of time in the production of further human capital. Accordingly, the level of human capital positively influences the efficiency to produce further human capital.[9] Leisure time is not explicitly considered in this analysis. Assuming that in each period (or at each point in time) the fixed amount of time allocated to either one or both activities is smaller than the total amount of time available, leisure could be considered to be a part of the "rest time" of the individual (leisure time is "exogenous").

The migrant's earnings capacity at time t is given by

$$E(t) = wH(t) \tag{3.1}$$

where w is the rental rate on one unit of services of human capital and $H(t)$ is the stock of human capital at t. $E(t)$ is the migrant's earnings potential, i.e. the value

[8]Note that in a discrete model context, the migrant would have to decide for every period about the fraction of time to be allocated to either activity. In a continuous formulation, every such period reduces to one point in time. Therefore, time in a continuous formulation has a dual role: it drives the migrant along his duration cycle, and, at each point in time, it has to be allocated to specific activities.

[9]This assumption follows Ben-Porath (1967) and Heckman (1976).

of the maximum amount of services the migrant can offer to the labor market. In order to increase future earnings, the migrant may invest part of his human capital stock at t into the production of further human capital. Assuming for simplicity that the only input factor into the production of human capital is human capital itself, the production relation is characterized by the following expression:

$$K(t) = F(H(t)s(t)) = \psi f(s(t)H(t)); \quad F'(.) > 0, \quad F''(.) < 0. \tag{3.2}$$

where $K(t)$ is the flow of produced human capital. $F(.)$ is the production function, assumed to be twice differentiable and strictly concave in it's argument $H(t)s(t)$ and $s(t)$ is the fraction of the human capital stock invested into the production of further human capital. ψ is an ability parameter. ψ may vary among individuals. For the following analysis, it will be assumed that $F'(x)_{x\to 0} \to c$, with c : finite. $s(t)$ is constrained by

$$0 \leq s(t) \leq 1 \tag{3.3}$$

If $s(t) = 1$, all human capital will be devoted to the production of further human capital. "Measured" or "actual" earnings at any t, $Y(t)$, are the difference between the migrant's earnings potential, $E(t) = wH(t)$, and the forgone earnings by allocating a fraction of time to investment activities:

$$Y(t) = (1 - s(t))\, E(t) \tag{3.4}$$

Consumption in the host country will enter the migrant's optimization problem as a constraint: since his objective is not to maximize utility during his stay in the host country, but to minimize the time necessary to realize his saving target, it will be assumed that he wants to sustain a level of consumption so as to maintain a utility level that is in a fixed relation to that he realized in the source country.[10] However, the size of the flow of consumption necessary to yield a constant flow of utility is not necessarily constant over the migrant's stay in the host country. Adopting the hypothesis that the utility gained from consuming a bundle of goods depends on the consumption pattern

[10]Note that this assumption does not imply that the migrant will realize the same overall utility as in the home country; consider a separable utility function $U(c, X) = U[u(c), v(X)]$, where c is consumption and X are all other utility-creating arguments like family, friends, environment etc. Only the first part $u(c)$ is of interest here.

of the social reference group,[11] such consumption will only produce a constant utility if the migrant will not change his social environment.

However, temporary migration is usually caused by a higher general wage level and a more favorable labor market condition in the host country, as compared to the home country. The country of immigration is generally characterized by higher standards of living, as compared to the countries of emigration. If the migrant integrates to a certain extend into the foreign society, he may gradually change his social reference group. Living initially in an environment consisting of compatriots, the migrant may slowly explore the foreign life style and adopt foreign consumption patterns. The utility he gains from a given bundle of goods may accordingly decline. The integration process will be correlated with migrants' efforts to accumulate country-specific human capital. Integration is often equivalent to wage-effective human capital investment: learning the language, adoption of foreign habits and the foreign nationality may often be a necessary requirement to obtain certain job positions. To maintain the prior level of utility, the migrant may have to change the composition as well as the amount of goods consumed. Therefore, the investment into country-specific human capital will, on the one side, increase the migrant's earnings capacity but, on the other side, may require him to increase his expenditures on consumption.[12]

Let the prior fixed level of utility from consumption be given by $\bar{u}$. Assume that $\bar{u} = u[c(t) - \gamma_1 G(H(t))] = ln[c(t) - \gamma_1 G(H(t))]$. $G(H(t))$ is the *integration function*, transforming a given stock of wage-effective human capital into *integration potential*. The coefficient γ_1 indicates in how far this integration potential is *consumption effective*, i.e. the degree to which integration implies an increase of consumption necessary to maintain a given level of utility. Solving for $c(t)$, the flow of consumption of goods can be written as follows:

$$c(t) = \gamma_0 + \gamma_1 G(H(t)); \quad G'(.) > 0; \quad G(H(0)) = 0; \quad \gamma_0 = e^{\bar{u}} \tag{3.5}$$

Integration is *accelerating* if $G''(.) > 0$, *decelerating*, if $G''(.) < 0$, and *constant*, if $G''(.) = 0$. In the analysis below, only constant and decelerating integration will be considered. If $\gamma_1 = 0$, the integration potential has no consumption augmenting impact. This would be the case if e.g. migrants, though having an integration potential given

[11]The notion that the level as well as the composition of consumption is strongly dependent on the consumption pattern of the social reference group was first brought up by Duesenberry (1949).

[12]To simplify the analysis, prices and availability of goods are assumed to be equal in both countries and the price level for consumption will be set equal to 1. Note that, since prices are equal in both countries, any change in size or composition of the migrant's consumption bundle is not due to changes in relative prices, but caused by a change in the migrant's social reference group.

by $G(H(t))$, are forced to live in special districts so that imitation effects or adoption of foreign consumption patterns are not probable to occur or if consumption patterns in the host country are very similar to those in the source country so that integration does not have a consumption augmenting effect. One could also think of γ_1 to depend on e.g. religious motives that prohibit the adoption of certain consumption patterns.

The stock of human capital is changing according to the following equation:

$$\dot{H}(t) = K(t) - \sigma H(t); \quad H(0) = H_0 \tag{3.6}$$

σ is the rate of depreciation of human capital and H_0 the stock of human capital that is wage effective at the time of immigration. The total savings at t, or, equivalently, the change in the stock of savings, may be written (in real terms):

$$\dot{A}(t) = rA(t) + w(1 - s(t))\, H(t) - c(t); \quad A(0) = A_0 \tag{3.7}$$

r is the interest rate, assumed to be constant over time, and A_0 is the stock of initial capital or savings. The migrant's optimization problem is now to minimize the amount of time necessary to accumulate a given saving target $\bar{A}$. He therefore solves the following optimization problem:

$$\begin{aligned} & max \int_0^T -1 dt \qquad (3.8) \\ s.t. \quad & (3.6), (3.7) \text{ and} \\ & A(T) \geq \bar{A} \\ & T \in [0, t_1] \end{aligned}$$

T is the point of return. Since T is endogenous to the problem, with t_1 as an upper bound, the optimization problem is one of a free-time horizon with one end point restriction.[13] Since neither the objective function nor the differential equations (3.6), (3.7) explicitly depend on t, the system is autonomous. In this formulation, the migrant has in each t to optimally decide about $s(t)$, the fraction of the existing stock of human

[13] $[t_0\ t_1]$ is the maximal duration of stay in the host country. t_1 is the point of return the migrant considered, before leaving his home country, as necessary to realize a given saving target in the "worst case", i.e. without any further investment into human capital.

capital to be invested into the further production of human capital, so as to steer the system from an initial state A_0 to the desired state $\bar{A}$ in a minimum amount of time.[14] The Hamiltonian for this problem is:

$$\aleph(H(t), A(t), \lambda_1(t), \lambda_2(t), s(t)) = -p_0 + \lambda_1(t)[rA(t) + w(1 - s(t))H(t) - (\gamma_0 + \gamma_1 G(H(t))] + \lambda_2(t)[F(H(t)s(t)) - \sigma H(t)] \tag{3.9}$$

$\lambda_1(t)$, $\lambda_2(t)$ and p_0 are costate variables, associated with equations (3.7), (3.6) and the objective function, respectively. In addition to the initial conditions and (3.6) and (3.7), first-order necessary conditions for an optimum are:

$$\dot{\lambda}_1^*(t) = -\frac{\delta \aleph}{\delta A} = -r\,\lambda_1^*(t) \tag{3.9-a}$$

$$\dot{\lambda}_2^*(t) = -\frac{\delta \aleph}{\delta H} = -\lambda_1^*(t)[w(1 - s^*(t)) - \gamma_1\, G'(H^*(t))] - \lambda_2^*(t)[F'(.)s^*(t) - \sigma] \tag{3.9-b}$$

$$-p_0 + \lambda_1^*(t)[rA^*(t) + w(1 - s^*(t))H^*(t) - (\gamma_0 + \gamma_1 G(H^*(t))] \tag{3.9-c}$$

$$+\lambda_2^*(t)[F(H^*(t)s^*(t)) - \sigma H^*(t)] \begin{cases} = 0 & : \quad T < t^1 \\ \geq 0 & : \quad T = t^1 \end{cases} \qquad \forall t, \quad 0 \leq t \leq T.$$

$$\lambda_1^*(T) \geq 0; \qquad \lambda_1^*(T)[A^*(T) - \bar{A}] = 0; \qquad \lambda_2^*(T) = 0. \tag{3.9-d}$$

$$[p_0, \lambda_1^*(t), \lambda_2^*(t)] \neq [0,0,0] \quad \forall t; \qquad p_0 = 0 \quad \text{or} \quad p_0 = 1. \tag{3.9-e}$$

$$\frac{\delta \aleph}{\delta s} = -\lambda_1^*(t) w\, H^*(t) + \lambda_2^*(t)\, F'(.)\, H^*(t) \begin{cases} \geq 0 & : \quad s(t) = 1 \\ = 0 & : \quad s(t) \in (0,1) \\ \leq 0 & : \quad s(t) = 0 \end{cases} \tag{3.9-f}$$

[14] If the duration of stay in the host country is legally restricted to a certain period length (e.g. Thai migrants in countries of the Middle East), the migrant would maximize the final amount of savings $A(T)$ in the given time subject to (3.6) and (3.7). Though the optimal paths of all variables are only identical if the saving stock achieved in the time restricted problem happens to be equal to the saving target in the free-time horizon problem (or v.v.), most of the following analytical results are valid in both cases. This follows from the structure of the optimization problem: in both cases, neither control variables nor state variables do appear in the objective function.

The interpretation of the costate variables λ_1 and λ_2 is straightforward. They indicate the shadow value of an additional unit of capital or human capital, respectively, in the maximization process. For the problem under consideration, $-\lambda_1(t)$ and $-\lambda_2(t)$ indicate the decrease of the time necessary to stay in the host country if $A(t)$ or $H(t)$, respectively, will be increased by a marginal unit. Condition (3.9-c) results from the special structure of the problem: since the duration of stay is endogenous and $A(t)$ is end point restricted, T has to be determined such as to set the value of the Hamiltonian for the optimal control- and state trajectories for all t equal to 0 (if the upper bound t^1 is not binding) or ≥ 0 (if the upper bound t^1 is binding).[15] $-\lambda_1(T)$ is then the decrease in the duration of stay if the saving target will be relaxed by one unit: $-\lambda_1(T) = dT/d\bar{A}$. From the complementary slackness condition in (3.9-d) it follows that $\lambda_1(T) = 0$ if $A(T) - \bar{A} > 0$, i.e. if the endpoint constraint is not binding. Since the problem is a minimal time problem, the constraint will be binding $\forall t$ if $\bar{A} > A_0$. p_0 is the costate variable associated with the objective function. Let $\int_0^T -1dt = x(T) = T$. Then $\dot{x}(t) = -1$ and $\dot{p_0} = -\frac{\delta \aleph}{\delta x(t)} = 0$. Consequently, p_0 is constant. For the problem under consideration, $p_0 > 0$ and, hence, $p_0 = 1$ without loss of generality.

The problem of the migrant in each t will then be to decide which fraction of the existing stock of human capital $H(t)$ to invest into the further production of human capital and which fraction to allocate to earnings activities. In each t the migrant uses as decision rule whether the investment of a marginal unit of human capital into the production of further human capital will be of more value, given his constrained objective, than allocating this unit to earnings activities. He has furthermore to consider that each additional unit of human capital produced will increase his stock of human capital and, therefore, promote integration and accordingly consumption expenditures.

In what follows the optimal path of $s(t)$ will first be analyzed. As obvious from (3.9-f), three policies may be considered to be optimal for some interval over the total time horizon $[0, T]$: (a) $s^* = 1$, (b) $s^* = 0$, (c) $s^* \in (0, 1)$. Section 3.3 only considers the case (c), i.e. an interior solution. The sensitivity of the path of the variables of interest to changes in individual characteristics will be analyzed in detail. Section 3.4 will then analyze the occurrence and duration of corner solutions ((a) and (b)).

[15] To simplify the analysis, it will be further on assumed that the upper bound, which is equal to the maximum amount of time the migrant considers as necessary to achieve the given saving target, will not become binding: $T < t_1$.

3.3 The Optimal Policy in the Case of an Interior Solution

The main concern of the analysis in this section is not to investigate the path of investment into human capital and the resulting paths of human capital stock and observed earnings for a "typical" migrant. The intention is rather to investigate how changes in characteristics that are likely to differ considerably among temporary migrants are responsible for changes in investment- and earnings patterns. Such differences in characteristics would be the level of ability, the level of skills upon arrival in the host country, the total length of stay, which, in turn depends on the migrant's saving target, and the value the stock of human capital acquired in the host country has for the migrant upon return to the source country. Profiles are further affected by the degree to which an integration potential, acquired by human capital investment, becomes consumption effective. The general dynamics of the system as developed in section 3.3.1 corresponds to the profiles of a representative temporary migrant and will serve as a basis for comparative dynamic analyses in later sections, investigating the impact of differences in several characteristics on migrants' investment- and earning's paths. In the following discussion it will be differentiated between *investment cycle* and *duration cycle*. The duration cycle is the total period a migrant stays in the host country, while the investment cycle signifies only the period of positive investment into human capital.

3.3.1 The Optimal Path

Let $\eta(t) = \lambda_2(t)/\lambda_1(t)$ be the relative shadow price of human capital in terms of real capital. η would correspond to the incentive of a migrant to invest into human capital. For $s(t) \geq 0, s(t) \neq 1$, and using (3.9-a), (3.9-b) and (3.9-f), the change of this shadow price over time is given by the following expression:

$$\dot{\eta}(t) = \gamma_1 G'(H(t)) - w + \eta(t)[\sigma + r] \tag{3.10}$$

This is a non-homogeneous differential equation. Using the transversality condition which implies that $\eta(T) = 0$, the solution is given by:

$$\eta(t) = e^{(\sigma+r)t} \int_t^T e^{-(\sigma+r)\tau}[w - \gamma_1 G'(H(\tau))]d\tau \tag{3.11}$$

The relative shadow price of a unit of human capital, $\eta(t)$, is the sum of all future net marginal contributions of this unit to the objective function. Let $[w - \gamma_1 G'(H(t))] =$

$\bar{\gamma}(t)$ be the marginal contribution of an additional unit of human capital stock.[16] Accordingly, in the case of a decelerating integration, $G''(.) < 0$ and $\delta\bar{\gamma}(t)/\delta H(t) > 0$. In the case of a constant integration $\delta\bar{\gamma}(t)/\delta H(t) = 0$. Since $\eta(T) = 0$, which follows from the transversality condition, $\dot{\eta}(t) \leq 0$ if $\eta(0) > 0$.[17]

To simplify the following analysis, the integration function will first be assumed to be a linear function in H: $G''(H(t)) = 0$ and $G'(H(t)) =$ constant. It follows that $\bar{\gamma}(t) = \bar{\gamma} > 0$. Accordingly, (3.11) simplifies to the following expression:

$$\eta(t) = \frac{\bar{\gamma}}{(\sigma + r)}\left[1 - e^{(\sigma+r)(t-T)}\right] \tag{3.12}$$

It is obvious from (3.12) that the size of $\eta(t)$ depends directly on the total length of stay, T, and on the degree to which some integration potential may become consumption effective, as indicated by γ_1. As mentioned above, differences in γ_1 may be due to different cultures, religions and integration possibilities of individual migrants. Variations in ability level ψ and the stock of initial human capital H_0 do not influence η directly.

In what follows, the paths of the stock of human capital H, total investment sH, measured earnings Y, and the fraction of human capital reinvested into the production s, will first be analyzed for a typical migrant, without differentiating among individual characteristics.

The path of optimal investment decisions is determined by the equilibrium condition (3.9-f). For the interior solution, this relation reduces to

$$F'(s(t)H(t))\,\eta(t) = w\,; \qquad s \in (0,1) \tag{3.13}$$

Since the production function is strictly concave and $\dot{\eta}(t) < 0$, it follows directly from (3.13) that the total investment into human capital sH must be strictly monotonically decreasing over time: $(\dot{sH}) < 0$. This can be easily seen by inverting (3.13):

$$s(t)H(t) = \Gamma\left(\frac{w}{\eta(t)}\right)\,; \qquad \Gamma' < 0 \tag{3.14}$$

It follows that $s(t)\dot{H}(t) = -\Gamma'\left(w/\eta(t)^2\right)\dot{\eta}(t) < 0$. The decrease in sH may be either due to a decrease in the fraction of human capital invested into further production, or to a

[16] In what follows, it will be assumed that $[w - \gamma_1 G'(H(t))] = \bar{\gamma}(t) > 0\ \forall t$.

[17] Note that, if the stock of human capital acquired in the host country is of further use to the migrant after return to the home country, $\lambda^2(T) \neq 0$ and, accordingly, $\eta(T) \neq 0$. This case will be considered in section 3.3.2.4.

decrease in the stock of human capital or to a decrease in both variables. However, for any positive investment, the stock of human capital will rather increase than decrease as long as the depreciation of human capital will not overcompensate the production of new human capital. Therefore, as long as the stock of human capital is increasing, the fraction of human capital invested into further production has to decrease: $\dot{s} < 0$. Since the total input into the production of new human capital is steadily decreasing, the stock of human capital has to decrease towards the end of the investment cycle, if the depreciation rate is positive. Depending on the size of the change in η, s may then either increase or decrease, but it will eventually go to zero. Analytically, the optimal change in the stock of human capital over time can be easily obtained from (3.6) and (3.14):

$$\dot{H}(t) = F(\Gamma(\frac{w}{\eta(t)})) - \sigma H(t) \tag{3.15}$$

As long as $F\left(\Gamma\left(\frac{w}{\eta(t)}\right)\right) > \sigma H(t)$, i.e. the production of human capital overcompensates the decay of the existing stock of human capital, the stock of human capital will increase. Since the first term in (3.15) is decreasing over time and the second term is increasing, the stock of human capital peaks at some t and decreases thereafter. For $\sigma = 0$, the stock of human capital will increase over the whole investment cycle. Since $\ddot{H}(t) < 0$, $H(t)$ is a strictly concave function in t.

Solving equation (3.15) results in the following expression:

$$H(t) = e^{-\sigma t}H(0) + \int_0^t e^{-\sigma(t-\tau)}F(\Gamma(\frac{w}{\eta(\tau)}))d\tau \tag{3.16}$$

The stock of human capital at time t is the sum of the integral of all depreciation weighted investments into human capital in previous periods and the depreciated initial stock of human capital. Dividing (3.14) by (3.16) gives the optimal fraction of human capital to be invested into reproduction, $s(t)$. Differentiation with respect to t yields

$$\dot{s}(t) = -\frac{\Gamma'(.)\frac{w}{\eta^2(t)}\dot{\eta(t)}}{H(t)} - \frac{\Gamma(.)\dot{H}(t)}{H(t)^2} \tag{3.17}$$

The first term in (3.17) is always negative. The second term will be negative or zero for $\dot{H}(t) \geq 0$. Consequently, if there is no decay of human capital ($\sigma = 0$), $s(t)$ will decrease over the whole investment cycle. However, if $\sigma \neq 0$, the second term may temporarily become positive at the end of the cycle. This follows from (3.15): if $\sigma > 0$, $\dot{H}(t)$ may eventually become negative at the end of the investment cycle. If

σ is sufficiently large, the second term in (3.17) may overcompensate the first term, inducing, consequently, $s(t)$ to increase again for a short period. However, since $\eta(t)$ is a monotonically decreasing function with $\eta(T) = 0$, it follows from (3.9-f) that, for $w > 0$, $s(T)$ must be equal to zero. Accordingly, s will finally decline, even if there may be intervals at the end of the investment cycle with $\dot{s}(t) > 0$.

How will measured earnings develop over the duration cycle? Measured earnings $Y(t)$ are given by equation (3.5). They are the difference between the migrant's earnings potential $E(t)$ and the fraction of human capital stock invested into the production of further human capital, valued with the rental price of human capital, w. The change in measured earnings is given by the following expression:

$$\dot{Y}(t) = w(1 - s(t))\,\dot{H}(t) - wH(t)\dot{s}(t) \tag{3.18}$$

The interpretation of (3.18) is straightforward: $\dot{H}(t)$ is the total change in the stock of human capital. If $\dot{H}(t)$ is positive, potential earnings $E(t) = wH(t)$ will increase by the evaluated change in human capital stock. Since, however, a part of this stock is reinvested into further production of human capital, the increase in measured earnings is reduced by the evaluated fraction s that is invested into the production process. Additionally, measured earnings will change by the evaluated change in the fraction $\dot{s}$ of human capital invested into the production process. This change is given by the second term in (3.18). Accordingly, as long as $\dot{H}(t) > 0$, it follows that $\dot{s}(t) < 0$. Measured earnings will steadily increase. In the case of a zero depreciation rate ($\sigma = 0$), earnings will increase as long as $s(t) > 0$. As if $s(t) = \dot{s}(t) = 0$ (which may occur not only in $t = T$, but also for some interval $[T - \theta, T]$ at the end of the duration cycle, as will be shown in section 3.4.2), $\dot{Y}(t) = 0$. In the case of a positive depreciation rate ($\sigma > 0$), $\dot{H}(t)$ will become zero at some t and negative thereafter. If $\dot{s}(t) < 0\ \forall\ t$, earnings will even then continue to rise as long as $(1 - s)\dot{H} - \dot{s}H > 0$. Measured earnings peak if $(1 - s)\dot{H} - \dot{s}H = 0$ and decline thereafter. Note that, consequently, measured earnings peak at a later point in time than human capital and potential earnings.

The main objective of the target saving migrant is to accumulate a certain stock of savings, $\bar{A}$. The change in the stock of savings is given by $\dot{A}(t)$. $\dot{A}(t)$ represents the savings of the migrant worker at t. Savings in t are the difference between income in t and consumption expenditures in t. Accordingly, the stock of savings for any t is the difference between the potential wealth in t, $PW(t)$, and the accumulated full consumption until t, $FC(t)$:

$$A(t) = PW(t) - FC(t) \tag{3.19}$$

with

$$PW(t) = A_0 e^{rt} + \int_0^t w[1 - s(\tau)]\, H(\tau) e^{r(t-\tau)}\, d\tau \tag{3.19-a}$$

$$FC(t) = \int_0^t [\gamma_0 + \gamma_1\, G(H(\tau))]\, e^{r(t-\tau)}\, d\tau \tag{3.19-b}$$

(3.19) is the budget constraint of the migrant. The change in the stock of savings over time, evaluated at $t = T$, is given by

$$\dot{A}(T) = rA(T) + [w\, H(T) - \gamma_1\, G(H(T)) - \gamma_0] \tag{3.20-a}$$

It follows from (3.20-a) and the additional condition (3.9-c):

$$\dot{A}(T) = \frac{p_0}{\lambda_1(T)} = \frac{1}{\lambda_1(T)} \tag{3.20-b}$$

Accordingly, $\lambda_1(T)$ is the increase in T if the saving target is expanded by one unit. For $w\, H(t) > \gamma_1\, G((H(t)) + \gamma_0\ \forall\, t$, this change is definitely positive. Consequently, the time being in the country does positively depend on the size of the saving target. It is shown in Appendix 1 that the total time horizon T is a strictly concave function of the saving target: $T = g(\bar{A})$, $g'(.) > 0$, $g''(.) < 0$.

Relations (3.19) and (3.9-c) close the system: They describe the optimal time being in the country, T, as a function of the saving target $\bar{A}$. They further determine, utilizing (3.13) additionally, $\lambda_1(0)$ and $\lambda_2(0)$ as functions of the parameters of the system. Some qualitative results on the dependence of the shadow prices λ_1 and λ_2 on the saving target are given in Appendix 1.

To summarize, if there is no depreciation of human capital and if it is optimal at the beginning of the duration cycle to invest a positive fraction of human capital into further production ($s(0) > 0$), total investment sH and the fraction to be reinvested s will both monotonically decrease over the whole cycle, while the stock of human capital, H, will increase. If, however, there is a decay of human capital stock, the stock of human capital will peak at some t and decrease thereafter. Total investment sH will decrease over the whole cycle. However, the fraction to be reinvested, s, may again increase for a short interval at the end of the investment cycle, but will eventually decline. For a zero depreciation rate, measured earnings will increase as long as the

investment into the production of human capital is positive. If $\sigma > 0$, measured earnings will decrease at the end of the duration cycle. They will, furthermore, peak at a later point than human capital. Finally, as outlined in the appendix, the optimal time being in the country is a strictly concave function of the saving target.

3.3.2 Optimal Investment and Differences in Individual Characteristics

Analyzing differences in investment- and earnings profiles among migrants as a consequence of differences in individual characteristics, one has first to determine in which way such differences in characteristics will enter the system. As mentioned above, the crucial relation for the dynamics of the system is equation (3.13). Technically, since

the rental rate for a unit of human capital, w, is constant, different investment- and earnings profiles among migrants result either from differences in the state and the rate of growth of η or from differences of the functional form and the arguments of $F(.)$. Since η is the relative shadow price the migrant attaches to any further unit of human capital, it would correspond to what is called in the literature an "investment incentive". Variables that directly influence η would accordingly provide a direct incentive to invest into human capital. η directly depends on two variables that may differ among individuals: the total horizon of stay, T, and the effect of integration on consumption expenditures, $\gamma(t)$. Furthermore, the value of the stock of human capital, acquired in the host country, upon return likewise affects η. The ability level ψ influences the system via the production relation. The stock of initial human capital, i.e. the skill level upon arrival H_0, has an impact on the system by changing the necessary input of s in order to guarantee that (3.12) will hold.

This section analyses in which manner a change in each of the above characteristics will influence the course of the variables of interest. It is obvious that, since the system is closed and interdependent, a change in one characteristic will induce a change in another characteristic: for instance, a higher ability level (entering the system via the production function) will allow the migrant to achieve the same saving target in a shorter amount of time T (entering the system via η). To get an idea about the effect of changes in characteristics, the analysis below will only consider a change in one characteristic in relation (3.13). In the example above, a change in the level of a ability would be analyzed for a fixed T, implying that saving targets differ. Results of the comparative dynamic analysis are illustrated by simulating the system for a

Cobb-Douglas production technology.[18]

Section 3.3.2.1. investigates the effect of changes in the level of ability. Section 3.3.2.2. considers changes in the initial skill level, section 3.3.2.3 the impact of a change in the time horizon (resulting from a change in the saving target) and section 3.3.2.4 investigates in which way different purposes after return influence the optimal path of human capital investment. Finally, section 3.3.2.5. analyzes in which way properties of the integration function and changes of the parameter γ_1 influence the system.

Different Levels of Abilities

The empirical finding that earnings of foreign workers overtake those of natives after an adaptation period is explained by migrants having greater innate abilities than native workers (see, e.g., Borjas (1989), Chiswick (1978, 1986), and Meng (1987)). However, it is not clearly specified in the literature in which way ability should have an impact on the migrant's earnings profile. Does an increase in ability steepen earnings profiles by providing an investment incentive? The comparative dynamic results of this section will point out the impact of a change in ability on earnings- and investment profiles. Results are illustrated by simulating the system, using a Cobb-Douglas type of production technology.

In equation (3.3), ability was introduced as a shift parameter ψ of the production function of human capital. This parameter may differ among migrants. Rewriting the production relation as $F(s(t)H(t)) = \psi f(s(t)H(t))$, inversion of (3.12) and differentiation with respect to ψ results in the following expression:

$$\frac{\delta s(t)H(t)}{\delta \psi} = \frac{\delta \xi\left(\frac{w}{\eta(t)\psi}\right)}{\delta \psi} = -\xi' \frac{w}{\eta(t)\psi^2} \tag{3.21}$$

where $\xi(.)$ is the inverse function of $f'(.)$. Strict concavity of the production relation implies that the expression in (3.21) is positive, for $t < T$. Accordingly, for any positive investment ($0 < s < 1$), the total input into the production of human capital at a given t will be the higher the higher the ability level. Whether this difference will increase or decrease over the whole investment cycle depends on the sign and the magnitude of the

[18]Note that, in the case of a Cobb-Douglas type of technology, $F'(x)_{x\to 0} \to \infty$. Accordingly, it follows from (3.9-f) that $s(t) > 0$ for $t \in [0,T)$. Therefore, a Cobb-Douglas technology excludes a period for which $s = 0$ (except in T), as will be discussed in section 3.4. However, because of its simple properties, such technology will be used to simulate the optimal path of variables in the case of an interior solution.

second derivative of the function $\xi(.)$.[19] Since, however, the path of η is not affected by changes in ψ, the gap between the total investment of migrants with different ability levels will eventually decline and vanish for $t = T$. It is outlined in Appendix 2 that the stock of human capital is higher for a higher abled migrant throughout the investment cycle. Furthermore, a higher ability will lead to steeper human capital profiles and a later peak point in human capital stock. The fraction of human capital reinvested into further production of human capital is initially higher for migrants with a higher level of abilities, but will gradually adjust to the level of those with lower abilities.

Measured earnings are lower for the higher abled migrant at the beginning of the duration cycle and higher at the end of the duration cycle:

$$\frac{\delta Y(0)}{\delta \psi} < 0; \qquad \frac{\delta Y(T)}{\delta \psi} > 0 \tag{3.22}$$

Earnings profiles will accordingly cross over at some $t' > 0$. The optimal paths of investments, human capital stock and earnings are illustrated in figure 1-4. Figure 1 shows the profiles of total investment of migrants who differ only in their ability level (and, since T is assumed to be equal for both migrants, implicitly in $\bar{A}$). The dotted line represents the investment path of the high ability migrant. His total investment is clearly higher than that of the migrant with lower abilities, but the difference declines over the investment cycle. Figure 2 illustrates the path of human capital and figure 3 the path of measured earnings. Note that for both migrants, measured earnings peak at a later point in time than the stock of human capital, as pointed out in the theoretical analysis. Furthermore, the high ability migrant reaches his peak point of human capital stock later than the low ability migrant. (see Appendix 2). The earnings profile of the higher abled migrant is clearly steeper than that of the lower abled migrant. After being initially lower, earnings of the higher abled migrant "cross over" with those of the lower abled migrant and continue to increase more rapidly. Figure 4 illustrates the respective investment paths'. The fraction of human capital to be reinvested into the production process is higher for the higher abled migrant; however, profiles finally coincide.

To summarize , earnings profiles of high ability migrants are not only steeper than those of low ability migrants, but high ability migrants do also invest longer into human capital (this result is derived in Appendix 2). Being initially lower, their earnings profiles will ultimately cross over with those of low ability migrants. Furthermore, ability does not provide an investment incentive. This follows directly from (3.12): $\delta\eta(t)/\delta\psi = 0$. Stronger investments and steeper earnings profiles are therefore not

[19]It is shown in Appendix 2 that the difference among profiles is decreasing if $\xi'' f' f'' < -1$.

a consequence of incentives, but a consequence of lower marginal costs of producing human capital. The results support the hypothesis that higher ability of migrants would be an explanation for a cross-over of migrants' earnings with those of native workers.

Different Skill Levels upon Arrival

The initial stock of human capital that is specific to the labor market of the host country may vary considerably among migrants. The higher the divergence of labor market conditions between source- and host region, the lower will be the stock of initial human capital that is directly transferable to the needs of the foreign labor market. Accordingly, migrants from countries with labor markets that differ considerably from that of the immigration country will arrive with a low level of skills corresponding to the needs of the host country labor market. In the literature it is argued that, the larger the divergence between labor markets and, accordingly, the lower the migrant's level of skills applicable to the needs of the host country, the steeper would be the migrant's earnings profile (see, e.g., Chiswick 1978, 1986). It will be shown below that the initial level of skills, although changing the location of the migrants earnings profile, will affect its steepness only via the depreciation rate.

Differences in the level of skills upon arrival are captured in H_0. It follows directly from (3.14) that differences in H_0 do not affect the total investment into human capital:

$$\frac{\delta\, s(t)H(t)}{\delta\, H(0)} = 0 \tag{3.23}$$

Consequently, total investment into further human capital production will not vary among migrants with different initial skill levels. It follows from (3.14) and (3.15) that, for a zero depreciation rate ($\sigma = 0$), a higher stock of initial human capital results in a parallel upward shift of the human capital profile. However, if $\sigma > 0$, an increment in the initial skill level will shift the human capital profile upwards, but it will decrease the rate of growth of human capital:

$$\frac{\delta\, H(t)}{\delta\, H(0)} = e^{-\sigma t} > 0\,; \qquad \frac{\delta\, \dot{H}(t)}{\delta\, H(0)} = -\sigma\, e^{-\sigma t} < 0 \tag{3.24}$$

If the depreciation rate is positive, profiles of human capital stock will peak at an earlier t' for migrants with a higher initial skill level: $(\delta\, t'/\delta\, H(0)) < 0$.[20] Figure 5 illustrates

[20]The derivation of this result follows the same pattern as the respective result for different levels of ability, as outlined in Appendix 2. Since $\dot{H}(t') = 0$, it follows that $\frac{\delta\, t'}{\delta\, H(0)} = -\frac{\sigma\, e^{-\sigma t'}}{F'' H' \frac{\partial s}{\partial t'}} < 0$.

typical profiles of human capital stock for a positive depreciation rate. The dotted line represents the migrant with a higher initial stock of human capital.

The fraction reinvested into human capital production in $t = 0$, $s(0)$, must be lower the higher $H(0)$. This follows directly from (3.13). Since total investment into human capital is not affected by the initial stock of human capital, it follows immediately that the investment path is the flatter the higher $H(0)$. Investment paths' are illustrated in figure 6.

Measured earnings will follow the same pattern as the stock of human capital. For $\sigma = 0$, measured earnings will increase at a lower rate the higher the initial stock of human capital. This can be directly seen by rewriting (3.5):

$$Y(t) = w\,H(t) - s(t)H(t)\,w$$

Since $\delta[s(t)H(t)]/\delta H(0) = 0$, it follows that

$$\frac{\delta Y(t)}{\delta H(0)} = w\,e^{-\sigma t} \tag{3.25}$$

For the non depreciation case, measured earnings profiles are parallel shifted by $wH(0)$. Earnings profiles are illustrated in figure 7, for $\sigma > 0$.

Accordingly, a change in the initial level of skills, although shifting the location, changes the slope of earnings profiles only by way of the depreciation rate. Since $\delta\eta(t)/\delta H_0 = 0$, a lower initial skill level does not provide any incentive effect, nor does it influence the marginal cost of producing human capital. In terms of an empirical analysis, skills upon arrival should mainly be explained by shifts in the intercept term. Slope coefficients should only change if the depreciation rate is large.

Differences in the Saving Target and the Length of Stay

The time the migrant intends to stay in the host country depends positively on his saving target $\bar{A}$ (see Appendix 1). Depending on individual characteristics and situations, saving targets and, accordingly, durations of stay in the host country are likely to vary considerably among migrants.[21] The length of residence T directly influences the relative shadow price of a unit of human capital, η (see figure 8). Changes in T will

[21] Qualitative results of the analysis apply as well if the time being in the country is restricted by e.g. immigration laws and the migrant wants to maximize the stock of savings during this period. A higher saving target would then correspond to a longer residence permit.

therefore provide an investment incentive. It follows from (3.12) that a longer duration of stay has a positive impact on both, size and rate of change of η:

$$\frac{\delta \eta(t)}{\delta T} > 0; \qquad \frac{\delta \dot{\eta}(t)}{\delta T} > 0 \tag{3.26}$$

Differentiating (3.14) with respect to T, one can easily verify that total investment into human capital will likewise increase with a rise in T. Accordingly, migrants with the intention to stay longer in the host country should have a higher stock of human capital throughout their migration history. It follows from (3.15) and (3.16):

$$\frac{\delta H(t)}{\delta T} > 0; \qquad \frac{\delta \dot{H}(t)}{\delta T} = -F'\Gamma' \frac{w}{\eta(t)^2} \frac{\delta \eta(t)}{\delta T} - \sigma \frac{\delta H(t)}{\delta T} \tag{3.27}$$

The change in the growth of human capital is positive before the peak point $\dot{H} = 0$ is reached and negative thereafter. According to (3.27), and for $\sigma = 0$, the profile of human capital stock of a migrant with a longer intention to stay is steeper throughout the investment cycle.

The fraction of human capital stock reinvested into further production is, for $t = 0$, the higher, the longer the horizon T. However, the evaluation of $\delta s(t)/\delta T$ for $0 < t < T$ is undetermined in sign.

$$\frac{\delta s(0)}{\delta T} > 0; \qquad \frac{\delta s(t)}{\delta T} = \frac{1}{H(t)} \left[\frac{\delta s(t) H(t)}{\delta T} - \frac{\delta H(t)}{\delta T} s(t) \right] \tag{3.28}$$

The first term in brackets of the second expression in (3.28) is the change in total input if T is changing. If $H(t)$ would not be affected by a change in T, this would exactly be the increase in $s(t)$ that is necessary to guarantee that the equilibrium condition (3.13) holds. However, since H is likewise affected by a change in T, the first term will be reduced by the change in the stock of human capital as a reaction in the change in T, multiplied with the fraction of human capital invested into further production. Since $(\delta H(0)/\delta T) = 0$, the second term is zero for $t = 0$, but will increase thereafter.

The change in measured earnings, induced by an increment in T, is given by the following expression:

$$\frac{\delta Y(t)}{\delta T} = w \left[\frac{\delta H(t)}{\delta T} [1 - s(t)] - \frac{\delta s(t)}{\delta T} H(t) \right] \tag{3.29}$$

The first term in (3.29) is the change in measured earnings, resulting from a change in human capital stock available for earnings activities. The second term is the cost

increase which results from a higher investment effort as a consequence of an increase in T. It follows directly from (3.29) and $(\delta H(0)/\delta T) = 0$ that $(\delta Y'(0)/\delta T) < 0$. Since $s(T) = 0$, $(\delta Y(T)/\delta T) > 0$. Accordingly, initial earnings are lower for those who intend to stay longer in the host country. Since their earnings paths are steeper, earnings are likely to cross over at some $t > 0$. Figure 9 illustrates the path of measured earnings for two identical migrants who differ only in their saving target and, therefore, T.

The analytical results indicate that the duration of stay of a migrant has a strong impact on his investment behavior and the steepness of his earning's profile. A longer duration of stay (and, accordingly, a higher saving target) provides an investment incentive by directly influencing the value of each unit of human capital acquired. If estimating earnings profiles empirically, an omission of this variable may accordingly lead to a considerable estimation bias.[22] This becomes obvious from figure 9: If neglecting the impact of the duration of stay on earnings, and observing two otherwise identical migrants at t^*, one would accordingly impose the wrong restriction of identical earnings profiles on the estimation equation. An empirical test on the hypothesis that migrants who intend to stay longer in the host country should have steeper earnings profiles is provided in chapter 2. The empirical findings support the results derived above.

Differences in Purposes after Return

Up to this point, it was assumed that the stock of human capital accumulated in the host country is of no further use for the migrant after return to his home country. This would be the case if, for instance, the migrant intends to retire after return and live on his savings accumulated in the host country. However, if the migrant has not only the intention to accumulate a certain stock of human capital, but, additionally, wishes to acquire certain skills that are of further use to him after return, the results of the analysis may change. For instance, the migrant worker may want to establish his own business in the home country for which he needs human capital that he can only acquire in the host country. Human capital acquired in the host country may as well help him to get better jobs upon return to the home country.[23]

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[22]Note that the appropriate variable in a non-deterministic world would be the *expected* total duration of stay.

[23]The "training aspect" of temporary migration seems to be considered as an important positive effect by the countries of origin. Mehrländer (1980) reports that "... employment abroad was expected to improve the training of the workers concerned, ultimately creating a larger reservoir of skilled labor in the countries of origin" (p.82).

In what follows, it will be pointed out in which way earnings profiles of migrants who intend to accumulate not only a stock of savings, but also some stock of human capital, differ from those of migrants who do not attach any value to the human capital acquired in the host country after return. Let $\eta^A(t)$ denote the relative shadow price of a unit of human capital for a migrant who wants to accumulate a certain stock of human capital. $\eta(t)$ is further defined as in (3.12). From the endpoint restriction on $H(T)$, i.e. $H(T) \geq \bar{H}$, where $\bar{H}$ is the level of human capital to be accumulated, it follows that $\lambda_2(T) \geq 0$ and $\lambda_2(T)(H(T) - \bar{H}) = 0$. After appropriately reformulating and solving the optimization problem, it follows:

$$\eta^A(t) = \eta(t) + e^{(\sigma+r)(t-T)}\eta^A(T) \tag{3.30}$$

It will further be assumed that the relative value of a unit of human capital in T is larger than zero: $\eta^A(T) > 0$.[24] Accordingly, it follows from (3.30) that $\eta^A(t) > \eta(t)\ \forall\ t$. The objective of the migrant to acquire a certain stock of human capital in the host country may therefore provide a positive incentive to invest into country specific human capital. Differentiation of (3.30) with respect to t reveals that the relative value of human capital decreases with a lower rate if $\eta^A(T) > 0$. This difference is the higher, the higher $\eta^A(T)$.

$$\dot{\eta}^A(t) = \dot{\eta}(t) + (\sigma + r)\, e^{(\sigma+r)(t-T)}\, \eta^A(T) \tag{3.31}$$

It is immediately obvious from (3.13), (3.30), (3.31) and the strict concavity of the production relation that total investment into human capital sH will be higher for a migrant who wishes to accumulate some stock of human capital.[25]

To analyze the effect of a change in the positive value of human capital stock in T on the path of human capital and measured earnings, one simply substitutes $\eta(t)$ by $\eta^A(t)$ and analyzes the change in the state and growth of the respective variables as a result of changes in $\eta^A(T)$. As outlined in Appendix 3, an increase in $\eta^A(T)$ will positively affect the stock of human capital $H(t)$ for all t and will have a steepening impact on profiles before and after the peak point of human capital stock. Furthermore,

[24]Note that this implies that the stock of human capital the migrant wishes to accumulate in the host country is larger than the stock of human capital he would acquire anyway (i.e. by solving the formerly considered optimization problem that imposes no restriction on $H(T)$). If the constraint on $H(T)$ will not be binding, it follows from the complementary slackness condition that $\lambda_2(T) = 0$ and, consequently, the optimization problem would be equivalent to the one treated above: $\eta^A(t) = \eta(t)$.

[25]Note that, for $\eta^A(T) > 0$, $s(T)$ and $s(T)H(T)$ do not have to be equal to zero at the end of the investment cycle, as it is the case if $\eta(T) = 0$.

the initial fraction of human capital to be reinvested into further production in $t = 0$ is higher the higher $\eta^A(T)$. However, this difference will diminish over time.

Measured earnings change according to the following equation:

$$\frac{\delta Y(t)}{\delta \eta^A(T)} = w \left[\frac{\delta H(t)}{\delta \eta^A(T)} - \frac{\delta s(t)H(t)}{\delta \eta^A(T)} \right] \tag{3.32}$$

In $t = 0$, measured earnings of a migrant who wishes to accumulate some stock of human capital are below those of a migrant without such intentions. However, earnings may eventually cross over at some $t > 0$. Note that $(\delta Y(T)/\delta \eta^A(T))$ is not necessarily positive since $s(T)H(T) \geq 0$.

According to the above analysis, the migrant's intention to accumulate a certain stock of human capital in the host country is likely to provide an incentive to invest into human capital. Earnings profiles of such migrants are steeper, but it may take quite long until they cross over with those of comparable migrants without the intention to accumulate a certain stock of human capital until T. For the empirical analysis, the results indicate that migrants' intention to accumulate some stock of human capital has not only an impact on the size of the intercept, but also on slope coefficients.

The shadow value of human capital and the path of measured earnings are illustrated in figure 10 and figure 11. The dotted line represents the migrant with further intentions after return.

Differences in Consumption Patterns

Up to now the analysis merely considered a constant integration. Furthermore, no attention was paid to the size of γ_1, the parameter that indicates in how far a given integration potential becomes consumption effective. As pointed out above, the size of γ_1 may depend on the specific situation of the migrant in the host country. Legal restrictions and migration policy in the host country may cause γ_1 to be extremely small or even equal to zero. Cultural differences and religious motives may likewise restrict a given integration potential from becoming consumption effective, thereby reducing γ_1. Consequently, migrants from different countries and with different cultural backgrounds may differ considerably in the extend to which their acquired integration potential becomes consumption effective. If migrants of different origin are, additionally, treated differently in the host country, such differences will vary even more.

Furthermore, the integration function is not necessarily a constant function of the stock of human capital accumulated in the host country. Integration may well

be decelerating. This would indicate that the human capital acquired for the foreign labor market at an early stage is more integration effective than more specific human capital acquired at later stages. This seems quite reasonable since early investments may comprise the adoption of working patterns, working rules and language, while later investments may be much more work specific and, therefore, less integration effective.

The following analysis will investigate the impact of a change in the parameter γ_1 on investment and earnings pattern for the case of a constant integration. Furthermore, constant integration will then be compared with decelerating integration.

A change in γ_1 has a direct and an indirect impact (via the integration function and the stock of human capital) on the relative shadow price of a unit of human capital, η:

$$\frac{\delta \eta(t)}{\delta \gamma_1} = \int_t^T e^{(\sigma+\tau)(t-T)} \left[-G'(H(\tau)) - \gamma_1 G''(H(\tau)) \frac{\delta H(\tau)}{\delta \gamma_1} \right] d\tau \qquad (3.33)$$

In the case of a constant integration, the second term in (3.33) vanishes. Expression (3.33) is then definitely negative: The higher the extend to which a given integration potential becomes consumption effective, the lower the relative shadow price of a unit of human capital. An increase in γ_1 would therefore provide a negative incentive effect. However, if the integration process is decelerating, any additional unit of human capital will increase consumption expenditures by less than the former unit. An increase in the stock of human capital as a result of an increase in γ_1 will therefore raise the earnings potential by more than the integration potential. This effect is captured by the second term in (3.33). This indirect effect of a change in γ_1 should be considerably smaller than the direct effect. For $(\delta H/\delta \gamma_1) > 0$ (see below), it then follows that $G'(.) + \gamma_1 G''(.)(\delta H/\delta \gamma_1) > 0$. Accordingly, $(\delta \eta(t)/\delta \gamma_1) < 0$.

For the change in the total investment into human capital as a reaction of a change in γ_1, one obtains:

$$\frac{\delta s(t) H(t)}{\delta \gamma_1} = -\Gamma'(.) \frac{w}{\eta^2(t)} \frac{\delta \eta(t)}{\delta \gamma_1} \qquad (3.34)$$

The expression in (3.34) is negative. Consequently, the higher γ_1, the lower is the total investment into human capital stock. Furthermore:

$$\frac{\delta \dot{H}(t)}{\delta \gamma_1} = -F'\Gamma'\frac{w}{\eta^2}\frac{\delta \eta}{\delta \gamma_1} - \sigma\frac{\delta H(t)}{\delta \gamma_1} \tag{3.35-b}$$

It is obvious from (3.35-a) and (3.35-b) that, the larger γ_1, the lower the stock of human capital and the flatter profiles of human capital stock. The rate of change of human capital stock is lower before and after the peak point. One can easily show that, for small σ, the peak point t' of human capital stock will be the earlier the higher γ_1. The fraction to be reinvested into human capital in $t = 0$, $s(0)$, is the smaller the higher γ_1. However, this difference is decreasing over time. Measured earnings will change according to the following expression:

$$\frac{\delta Y(t)}{\delta \gamma_1} = w(1 - s(t))\frac{\delta H(t)}{\delta \gamma_1} - wH(t)\frac{\delta s(t)}{\delta \gamma_1} \tag{3.36}$$

The first term in (3.36) is the impact on measured earnings of the change in γ_1 by changing the stock of human capital. For $t > 0$, this effect is clearly negative. The second term is the change in earnings due to a change in the fraction of human capital allocated to further investment into human capital. Since $(\delta s/\delta \gamma_1) < 0$, this effect on earnings is positive. It follows that $(\delta Y(0)/\delta \gamma_1) > 0$ (since $(\delta H(0)/\delta \gamma_1) = 0$) and $(\delta Y(T)/\delta \gamma_1) < 0$. Accordingly, migrants who, due to either cultural and religious or legal restrictions, to a larger extent integrate into the foreign society in such a way that their integration potential becomes consumption effective, have higher measured earnings in the beginning of their duration cycle. This is due to a lower investment into human capital. At the end of the duration cycle, however, their earnings are lower. Earnings will cross over with those of migrants with a lower γ_1 at some $t > 0$.[26] Earnings paths are illustrated in figure 12. The results indicate that migrants who are not heavily restricted to integrate into the foreign society, neither by legal restrictions nor by cultural constraints, should have earnings profiles that are flatter than those of migrants who do not integrate so easily. The analysis supports empirical findings that migrants, who are culturally more different, have steeper earnings profiles (see, e.g., Chiswick (1978), Chiswick and Miller (1985), and Meng (1987)). However, the reason would not be that those migrants have a lower stock of readily transferable initial human capital upon arrival (see section 3.3.2.2), but rather that easy integration provides a disincentive effect for human capital investment and increases demand for consumption.[27] If estimating earnings equations, one should accordingly differentiate between variables that represent the level of skills of a migrant, explaining differences

[26]Since the second term in (3.36) is very small, compared with the first term, the crossover point should be at an early stage.

[27]Note that an increase in w, the rental rate on human capital, would have an opposite effect,

in the intercept term, and variables that measure the degree to which a migrant may adopt foreign consumption patterns, explaining differences in slope parameters.

The properties of the integration function will likewise influence the relative shadow price of human capital and, consequently, investment as well as human capital stock and earnings. Keeping γ_1 constant, the size of $\eta(t)$ depends on the second derivative of the integration function. The smaller $G''(.)$, the higher is $\eta(t)$ for any $t < T$. For illustration, consider the extreme case: if comparing a constant and a decelerating integration process, it follows from (3.10) and (3.11):

$$\Delta\eta(t) = \eta^D(t) - \eta^C(t) = \int_0^t e^{(\sigma+\tau)(t-\tau)} \left[\int_0^\tau \dot{\gamma}(s)ds \right] d\tau > 0, \text{ with } \dot{\gamma}(t) = [-\gamma_1 G''(.)\dot{H}(t)] \tag{3.37}$$

η^C, η^D are the relative shadow prices in the case of constant and decelerating integration, respectively. For $\sigma = 0$, $\Delta\eta(t)$ is a strictly monotonically decreasing function in t, with $\max \Delta\eta = \Delta\eta(0)$ and $\min \Delta\eta = \Delta\eta(T) = 0$. Since $\Delta\eta$ is the larger the smaller $G''(.)$, it follows that total investment will positively depend on the size of $-G''(.)$. Accordingly, human capital stock will increase faster, if integration is decelerating, as will measured earnings.

3.4 Full and Zero Investment

The analysis above is solely concerned with the optimal path of relevant variables if $s \in (0,1)$. However, it might well be the case that it is optimal for the migrant to invest all or none of his human capital into further production. The condition for a boundary solution to be optimal follows directly from (3.9-f):

$$F'(s(t)H(t))\,\eta(t) \begin{cases} \geq w & : \quad s(t) = 1 \\ \leq w & : \quad s(t) = 0 \end{cases} \tag{3.38}$$

The interpretation of (3.38) is straightforward: If the marginal benefit of all human capital, if invested into further production, is higher or equal to the marginal costs w that arise by drawing off the last unit from earnings investment, then $s(t) = 1$. Investment will be zero if marginal costs are higher or equal to the value of the marginal product of the first unit to be invested.

providing a positive investment incentive and thus generating earnings profiles that are steeper but starting out with lower earnings in $t = 0$.

For the following analysis, recall the following property of the production relation:

$$F'(sH)_{sH\to 0} = \psi f'(sH)_{sH\to 0} \to c$$

Accordingly, the marginal product of the first or last infinitesimally small fraction of human capital invested into further production is finite and goes in the limit to c.[28]

The following analysis will investigate whether and in which order the policies of full and zero investment could be considered by the migrant to be optimal over some interval of his duration cycle. The dependence of the length of boundary policies on characteristics of the migrant will further be pointed out.

3.4.1 Full Investment

The first question to be answered is whether it is optimal for the migrant to invest over some interval his entire stock of human capital into the production of further human capital, i.e. whether there exists a period for which $s(t) = 1$ forms an optimal investment policy. As obvious from (3.4), measured earnings would in this case be equal to zero. The shadow value of a unit of human capital for $s(t) = 1$ follows from the first order condition of the maximization problem and is given by the following expression:

$$\eta(t) = -\bar{\gamma}\left[\int_t^T e^{\int_\tau^T [(\sigma+r)-F'(.)]ds} d\tau\right] \tag{3.39}$$

It follows that $\eta(0) < 0$, $\eta(T) = 0$ and $\dot{\eta}(t) > 0$. Consequently, if $s(t) = 1$, $\eta(t)$ will always be smaller or equal to zero. This is in contradiction to the equilibrium condition (3.38): if $s(t) = 1$, $F'(.)\,\eta(t) \geq w$. If $w > 0$ and $F'(.) > 0$, $\eta(t) \leq 0$ will always contradict the equilibrium condition. Accordingly, there will be no period of full investment into the production of human capital over the whole duration cycle of the temporary migrant.[29]

[28]Note that this condition is not fulfilled for a Cobb Douglas technology, which was used for simulation purposes, with $F'(x)_{x\to 0} \to \infty$, where $s(t) = 0$ will only occur if $\eta(t) = 0$. For any positive rental rate w, $s(t)$ will always be chosen small enough to fulfill (3.13), for $t < T$.

[29]The intuitive argument goes as follows: if $s = 1$, any unit of further human capital would rather increase than decrease the time being in the host country since further savings would not be accumulated, but savings would rather be used up. Since λ_2 indicates the decrease of time being in the country if the stock of human capital increases by one unit, the sign of λ_2 should change, which would then result in the contradiction outlined above.

3.4.2 Zero investment

From the equilibrium condition (3.38) follows that $s(t) = 0$ if $F'(.)\eta(t) < w$. Since $\dot{\eta}(t) \leq 0$, it follows that, whenever the evaluated marginal product of the first unit invested into the accumulation of human capital is smaller than the value of this unit if allocated to earnings activities, it would be optimal not to invest over the whole duration cycle. The size of the relative shadow price at 0, $\eta(0)$, depends crucially on the time the migrant intents to stay in the country, as can easily be seen from (3.12). The larger is T, the larger will be $\eta(0)$, keeping everything else constant.

It follows from (3.12) and (3.38) that the minimum length of stay necessary to induce the migrant to invest into the production of human capital is given by the following expression:

$$\tilde{T} = -\left[\frac{1}{\sigma + r}\right] ln\left(1 - \frac{w(\sigma + r)}{\bar{\gamma}F'(s(0)H(0))}\right) \tag{3.40}$$

Accordingly, if the migrant intends to stay less than $\tilde{T}$, it would be optimal for him not to undertake any investment into his human capital over his whole duration cycle. The critical $\tilde{T}$, below which no investment is worthwhile, depends on the migrant's individual characteristics as on global variables like w and r. For $\frac{w(\sigma+r)}{\bar{\gamma}F'(H(0)s(0))} < 1$, simple comparative statics reveal:

$$\frac{\delta \tilde{T}}{\delta \psi} < 0\,; \qquad \frac{\delta \tilde{T}}{\delta H(0)} > 0\,; \qquad \frac{\delta \tilde{T}}{\delta \gamma_1} > 0\,; \qquad \frac{\delta \tilde{T}}{\delta w} > 0\,; \tag{3.41}$$

Accordingly, the critical time a migrant has to stay in the host country to make any investment worthwhile is longer the higher the migrant's level of initial skills, the higher the degree to which some integration potential becomes consumption effective and the higher the rental rate on a unit of human capital. It is shorter the higher the migrant's abilities. When comparing two migrants with the same intended duration of stay, the one who is not likely to invest into human capital would be characterized by average or low abilities, but highly skilled, who is not restricted or constraint to adopt foreign consumption patterns. A high wage level in the immigration country reduces the likelihood that a migrant will invest into human capital.

Assume now that T is large enough, so that the migrant will undertake some investment into his human capital. It then follows from (3.12) that the relative shadow price of human capital is decreasing over time, with $\eta(T) = 0$.[30] Consequently, since

[30]This is, of course, not the case if the stock of human capital accumulated is of further use to the migrant upon return, as analyzed in section 3.3.2.4.

$\eta(t)$ is a continuous function, it follows from (3.38) that there must exist a period $[T-\theta, T]$, $\theta > 0$, without any investment, if the rental price for human capital, w, is positive. This period is characterized by the following inequality:

$$F'(s(\tau)H(\tau))\left[\frac{\bar{\gamma}}{(\sigma+r)}\left[1-e^{(\sigma+r)(\tau-T)}\right]\right] < w; \quad \tau \in [T-\theta, T] \tag{3.42}$$

The size of θ depends on the parameters of the problem and the technology of human capital production as well as on the stock of human capital at $(T-\theta)$, $H(T-\theta)$. If human capital production is very inefficient, or if the rental price for human capital w is very high, θ may be quite large. In Appendix 2 it is shown that the length of the investment cycle depends positively on the level of ability. If $\theta \geq T$, no investment into human capital will take place over the whole duration cycle. This case is then equivalent to the one discussed above.

The above considerations assumed a linear integration function: each additional unit of human capital stock will increase consumption expenditures necessary to maintain a constant level of utility in a linear way. However, integration may as well be decelerating. In this case, $G''(.) < 0$. Accordingly, each additional unit of human capital acquired will, although raising the migrant's earnings capacity by w, increase his integration potential by less than the former unit. It follows that $\dot{\gamma}(t) = [-\gamma_1 G''(.)\dot{H}(t)] \geq 0$ for $\dot{H}(t) \geq 0$. By differentiating (3.10) with respect to t it can easily be shown that, if integration is decelerating, η decreases faster than in the case of a constant integration:

$$\ddot{\eta}(t) = -\ddot{\gamma}(t) + \ddot{\eta}(t)[\sigma + r] \tag{3.43}$$

Note that $\ddot{\gamma} = 0$ if the integration is constant. It follows from (3.37) that $\Delta\eta(t)$, the difference between the shadow price in the case of constant and decelerating integration, is decreasing over time and vanishes for $t = T$. Accordingly, the length of a period over which η falls below a certain threshold $\bar{\eta}$ must be longer if integration is constant.

A period of zero investment $[T-\epsilon, T]$ will then be described by the following inequality:

$$F'(s(t)H(t))\int_t^T e^{(\delta+r)(t-\tau)}\,\gamma(\tau)d\tau < w\,; \qquad t \in [T-\epsilon, T] \tag{3.44}$$

If the integration is constant, $\epsilon = \theta$. If the integration is decelerating, $(\theta - \epsilon) = \alpha$, with $\alpha > 0$. The smaller $G''(.)$, the larger will be α. In other words: The length of the investment cycle depends positively on the size of $G''(.)$ and is largest for $G''(.) = 0$.

3.5 Summary and Conclusion

This chapter analyzes human capital investment and earnings pattern of temporary migrants who are target savers. The main purpose is to investigate in a human capital framework the impact of those characteristics, which are likely to differ considerably among temporary migrants, on the migrant worker's earnings situation. The results are contrasted with the hypotheses in the literature which are used to explain empirical findings of earnings pattern of migrant workers. The analysis provides a variety of implications for empirical studies. The model could provide a theoretical basis for empirical work if estimating earnings pattern of temporary migrants.

The main findings could be summarized as follows:

(1) Defining changes in the relative shadow price of a further unit of human capital in the migrant's optimization problem as *investment incentives*, the time the migrant intents to stay in the host country, being an increasing function of his saving target, provides a positive investment incentive. The longer a migrant wants to stay in the host country, the steeper will be his earnings profile. If estimating earnings profiles of temporary migrants who are likely to vary considerably in their total duration in the host country, this variable should be crucial to explain differences in migrants' earnings profiles. Furthermore, for migrants who only want to stay a short period in the host country it may be optimal not to invest at all into human capital. The critical time of stay necessary to make any investment worthwhile is relative longer for migrants with average or low ability levels, who are highly skilled and easily adopt foreign consumption patterns, and who emigrate to a high wage country.

(2) The intention to acquire some stock of human capital provides a positive incentive effect. If the migrant not only wants to accumulate some stock of savings, but additionally some stock of human capital which is of further use to him after return to his home country, he is likely to have a steeper earnings path, although his initial earnings position is lower. For empirical research, if estimating earnings equations for a population of temporary migrants, the value a migrant attaches to the stock of human capital acquired in the host country at the point of return may accordingly have an effect on the intercept as well as on slope coefficients.

(3) The more easily a migrant adopts foreign consumption patterns and integrates into the society of the host country, the lower should be his incentive to invest into human capital. Migrants who do not easily integrate and who, additionally, are constrained by cultural or religious motives or by legal restrictions to adopt foreign consumption patterns, should have relatively steeper earnings profiles. This would support empirical findings, indicating that earnings profiles of migrants coming from countries

with considerably different cultural environments are relatively steep. However, the steepness of earnings profiles would then not be explained by the low transferability of the stock of human capital upon arrival, as it is often hypothesized.

A higher rental rate on human capital provides a positive incentive effect.

(4) The stock of human capital upon arrival, though shifting the location of the migrant's earnings profile, affects the steepness only by way of the depreciation rate. If the depreciation of human capital is equal to zero, a change in the initial stock of human capital shifts the earnings profile parallely. The consequence for empirical research would be that skill levels, although explaining differences in the intercept term, do not explain differences in slope parameters. The level of skills has no incentive effect.

(5) A higher level of ability does not provide a direct incentive to invest into human capital, but it lowers the marginal cost of human capital production. High ability migrants have steeper earnings profiles and longer investment cycles than those with low abilities.

The main conclusion would be that the earnings position of a temporary migrant strongly depends on variables that do not have to be considered if analyzing earnings of native workers or permanent migrants. For an empirical analysis, this means that reliable estimates of earnings equations of temporary migrants require a more detailed database than would be necessary when analyzing earnings paths of native workers or permanent migrants.

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3.6 Appendix

Appendix 1: The Impact of the Saving Target on the System

The Dependence of $\bar{A}$ on T

Assume, for simplicity, the case of constant integration, with $G(H(t)) = \gamma_1 H(t)$. For $A^*(t)$, $H^*(t)$ and $s^*(t)$ satisfying the necessary conditions (3.6), (3.7) and (3.9), (3.19) implicitly determines T for a given saving target $\bar{A}$. It follows by the implicit function rule:

$$\frac{\delta T}{\delta \bar{A}} = \frac{1}{r\bar{A} + H^*(T)(w - \gamma_1) - \gamma_0} > 0 \tag{3.45}$$

and, furthermore:

$$\frac{d[\frac{dT}{d\bar{A}}]}{d\bar{A}} = \frac{\delta^2 T}{\delta \bar{A}^2} = -\frac{r}{[H^*(T)(w - \gamma_1) + r\bar{A} - \gamma_0]^2} < 0 \tag{3.46}$$

Consequently, the minimal time necessary to stay in the country is a strictly concave function of the saving target $\bar{A}$: $T = g(\bar{A})$, $g' > 0$, $g'' < 0$.

The Dependence of λ_1^0, λ_2^0 on $\bar{A}$

λ_1^0 and λ_2^0 are the shadow values for a unit of capital and human capital, respectively, in $t = 0$. They both depend in size on the saving target $\bar{A}$. Some qualitative results will be given below.

Since $s^*(T) = \lambda_2^*(T) = 0$, it follows from (3.9-c) and (3.19):

$$\dot{A}^*(T) = \frac{e^{rT}}{\lambda_1^0} = rA^*(T) + (w - \gamma_1)H^*(T) - \gamma_0, \quad \text{with } A^*(T) = \bar{A} \tag{3.47}$$

Consequently:

$$\ddot{A}^*(T) = r\dot{A}^*(T) + \dot{H}^*(T)(w - \gamma_1) = \dot{A}^*(T)\left[r - \frac{1}{\lambda_1^0}\frac{d\lambda_1^0}{dT}\right] \tag{3.48}$$

It follows from (3.48):

$$\frac{d\lambda_1^0}{dT} = -\frac{\dot{H}^*(T)}{\dot{A}^*(T)}(w - \gamma_1)\lambda_1^0 \tag{3.49}$$

Since $\dot{H}(T)^* = -\sigma H^*(T)$, (3.49) is equal to zero for $\sigma = 0$. In the case of a positive depreciation rate ($\sigma > 0$), $(d\lambda_1^0/dT) \geq 0$, since $(w - \gamma_1)H(t) - \gamma_0 > 0 \ \forall t$. It follows from (3.12) and (3.49):

$$\frac{d\lambda_2^0}{dT} = \frac{\bar{\gamma}}{[\sigma+r]}\left[1-e^{-T(\sigma+r)}\right]\frac{d\lambda_1^0}{dT} + \bar{\gamma}\lambda_1^0 e^{-T(\sigma+r)} \tag{3.50}$$

Consequently, $(d\lambda_2^0/dT) > 0$ for $\sigma \geq 0$. However, the increase in the shadow value of a unit of human capital as a consequence of a change in T in $t = 0$ is the higher the higher the rate of depreciation. It follows:

$$\frac{d\lambda_2^0}{dT}_{\sigma>0} > \frac{d\lambda_2^0}{dT}_{\sigma=0} \tag{3.51}$$

Combining the above results with (3.45) yield:

$$\left.\begin{array}{l}\frac{d\lambda_1^0}{dA} = 0\\ \frac{d\lambda_2^0}{dA} > 0\end{array}\right\} \text{ for } \sigma = 0 \quad \left.\begin{array}{l}\frac{d\lambda_1^0}{dA} > 0\\ \frac{d\lambda_2^0}{dA} > 0\end{array}\right\} \text{ for } \sigma > 0 \tag{3.52}$$

Consequently, the size of the saving target will not affect the shadow value of a unit of human capital stock for any t (since $\lambda_1(t) = e^{-rt}\lambda^0$) if $\sigma = 0$. It will, however, positively affect $\lambda_1(t)$ for $\sigma > 0$. For any $\sigma > 0$, the shadow value of a unit of human capital in $t = 0$ will increase as a consequence of a change in the saving target. This impact on λ_2^0 depends positively on the depreciation rate of human capital.

Appendix 2: Differences in Ability

Profiles of Total Investment

From (3.21), it follows directly for $(\delta \dot{sH}/\delta\psi)$:

$$\frac{\delta \dot{sH}}{\delta\psi} = \frac{\dot{\eta}f'}{\psi\eta}[\xi''f' + \xi'] \tag{3.53}$$

The first term in (3.53) is negative. Accordingly, the difference in profiles of migrants with different levels of abilities is decreasing over time if the second term is positive. Since the derivative of an inverse function is the reciprocal of the derivative of the original function, $\xi' = (1/f'') < 0$. It follows that the gap between total investment profiles will narrow over the investment cycle if $\xi''f'f'' < -1$.

Profiles of Human Capital Stock

It follows from (3.15) and $F(s(t)H(t)) = \psi f(s(t)H(t))$:

$$\frac{\delta H(t)}{\delta\psi} = \int_0^t e^{\sigma(\tau-t)}[f(\xi(.)) - \psi f'\xi'\frac{w}{\eta\psi^2}]d\tau > 0 \tag{3.54}$$

Furthermore, from (3.6):

$$\frac{\delta \dot{H}(t)}{\delta \psi} = [f(\xi(.)) - \psi f' \xi' \frac{w}{\eta \psi^2}] - \sigma \frac{\delta H(t)}{\delta \psi} \tag{3.55}$$

The first term in (3.55) is positive, the second term negative. It follows that, for a zero depreciation rate, higher abled migrants have a steeper profile of human capital stock. For $\sigma > 0$, the human capital profile of a higher abled migrant is steeper before and after the peak point.

In the peak point of human capital stock, $\dot{H}(t) = 0$. Accordingly, it follows from (3.15) that, for a given level of ability ψ, the peak point of human capital stock t' is implicitly determined by the following relation:

$$\psi f\left(\xi\left(\frac{w}{\eta(t')\psi}\right)\right) = \sigma H(t') \tag{3.56}$$

It follows by the implicit function rule and the envelope theorem:

$$\frac{\delta t'}{\delta \psi} = \frac{f(\xi(.)) - \psi f' \xi' \frac{w}{\eta(t')\psi^2} - \sigma \frac{\delta H(t')}{\delta \psi}}{\psi f' \xi' \frac{w}{\eta(t')^2 \psi} \dot{\eta}(t)} \tag{3.57}$$

The denominator in expression (3.57) is positive, the numerator ambiguous in sign. However, it follows from (3.54) that the numerator is positive for small σ. In this case, human capital stock profiles of higher abled migrants are not only steeper before and after the peak point, but they peak at a later t. (Such a case is illustrated in figure 2).

Profiles of Investment

The change in the fraction of human capital invested into the production process as a result of a change in ability is given by

$$\frac{\delta s(t)}{\delta \psi} = \frac{-\xi' \frac{w}{\eta(t)\psi^2}}{H(t)} - \frac{\xi(.) \frac{\delta H(t)}{\delta \psi}}{H(t)^2} \tag{3.58}$$

Since $(\delta H(0)/\delta \psi) = 0$, the second term disappears for $t = 0$. It follows that $(\delta s(0)/\delta \psi) > 0$. Accordingly, the fraction of human capital reinvested into further production in $t = 0$ will be the higher, the higher the level of ability. However, the second term in (3.58) is increasing over time. Accordingly, the difference in investment profiles of migrants with different levels of abilities will diminish over time. Whether profiles of migrants with different abilities will coincide at some t depends on the properties of the production function. Note that, if the production technology is such that $f'(x) \lim_{x \to 0} \to \infty$, $s(t) = 0$ only for $t = T$. Profiles will coincide at the end of the duration cycle (exactly, in $t = T$), which is then identical to the

investment cycle. Since a Cobb-Douglas type of technology has the above property, figure (4) illustrates such investment profiles for migrants with different ability levels. However, if $f'(x)\lim_{x\to 0} \to c$, the duration of the migrant may well be longer than his investment period. Furthermore, the length of the investment cycle is then depending on the ability level. This aspect is analyzed below.

Profiles of Measured Earnings

Inserting the optimal s^* and H^* into (3.4) and differentiating with respect to ψ yields:

$$\frac{\delta Y(t)}{\delta \psi} = w \int_0^t \left[e^{\sigma(\tau - t)} f(\xi(\frac{w}{\eta(t)\psi})) - \psi f' \xi' . \frac{w}{\eta(t)\psi^2} \right] d\tau + \xi' \frac{w^2}{\eta(t)\psi^2} \tag{3.59}$$

The kernel of the integral is positive for $t > 0$, the second term is negative for $t < T$. Accordingly, $(\delta Y(0)/\delta \psi) < 0$. At the beginning of the investment cycle, higher abled migrants have lower measured earnings. Earnings profiles will cross over at t', with $(\delta Y(t')/\delta \psi) = 0$. Since $(\delta Y(T)/\delta \psi) > 0$ (because the second term in (3.59) will eventually vanish at the end of the investment cycle), there will accordingly be a crossover point for some $t > 0$. If the depreciation rate is equal to zero ($\sigma = 0$), it follows from the strict monotonicity of the earnings function that the crossover point is unique. Note again that, depending on the production technology, the duration cycle may or may not coincide with the investment cycle.

Ability Level and Length of Investment Cycle

Let t'' characterize the end of the investment cycle. Consequently, $s(t'') = 0$. It follows by the implicit function rule:

$$\frac{dt''}{d\psi} = -\frac{\frac{\delta s}{\delta \psi}}{\frac{\delta s}{\delta t}} \tag{3.60}$$

$(\delta s/\delta \psi)$ is given by expression (3.58). However, for $s \to 0$, (3.58) can be written as:

$$\left[\frac{\delta s}{\delta \psi}\right]_{s\to 0} \to \frac{-\xi' \frac{w}{\eta \psi^2}}{H} \tag{3.61}$$

For $f'(sH)_{sH\to 0} \to c(H)$, expression (3.61) is greater than zero. It further follows for $\delta s/\delta t$:

$$\left[\frac{\delta s}{\delta t}\right]_{t\to t'} \to \frac{-\xi' \frac{w}{\eta^2 \psi} \dot{\eta}}{H} < 0 \tag{3.62}$$

Accordingly, an increase in the level of ability will increase the length of the investment cycle: higher abled migrants do invest over a longer period into their human capital than do lower abled migrants.

Appendix 3: Differences in Purposes after Return

Profiles of Human Capital Stock

If the constraint that requires that $H(t) \geq \bar{H}$ becomes binding, $\eta^A(T) > 0$. It follows:

$$\frac{\delta H(t)}{\delta \eta^A(T)} = -\int_0^t e^{-\sigma(t-\tau)} F'\Gamma' \frac{w}{\eta(t)^2} \frac{\delta \eta(t)}{\delta \eta^A(T)} d\tau \begin{cases} > 0 & : \quad \eta(T)^A > 0 \\ = 0 & : \quad \eta^A(T) = 0 \end{cases} \tag{3.63}$$

Accordingly, the stock of human capital is higher for all t if the migrant intends to accumulate a certain stock of human capital higher than the stock of human capital he would accumulate anyway: $H(T)^F < \bar{H}$, with $H(T)^F$: stock of human capital acquired in the unrestricted problem. The change in the growth of human capital stock as a result in a change in $\eta^A(T)$ is given by the following expression:

$$\frac{\delta \dot{H}(t)}{\delta \eta^A(T)} = -F'\Gamma' \frac{w}{\eta^2(t)} \frac{\delta \eta(t)}{\delta \eta^A(T)} - \sigma \frac{\delta H(t)}{\delta \eta^A(T)} \tag{3.64}$$

For a migrant with further intentions after return the human capital profile will be steeper before and after the peak point. The peak point of human capital stock will be later for this migrant if σ is sufficiently small:

$$\frac{\delta t'}{\delta \eta^A(T)} = \frac{-F'\Gamma' \frac{w}{\eta^2(t')} \frac{\delta \eta(t')}{\delta \eta^A(T)} - \sigma \frac{\delta H(t')}{\delta \eta^A(T)}}{F'\Gamma' \frac{w}{\eta^2(t')} \dot{\eta}} > 0 \tag{3.65}$$

Profiles of Investment

The change in the fraction to be reinvested as a reaction in changes in $\eta^A(T)$ is given by:

$$\frac{\delta s(t)}{\delta \eta^A(T)} = \frac{-F'\Gamma' \frac{w}{\eta^2(t)} \frac{\delta \eta(t)}{\delta \eta^A(T)}}{H(t)} + \frac{F(\Gamma(\frac{w}{\eta(t)})) \int_0^t \left[e^{-\sigma(t-\tau)} F'\Gamma' \frac{w}{\eta(t)^2} \frac{\delta \eta(t)}{\delta \eta^A(T)} \right] d\tau}{H(t)^2} \tag{3.66}$$

It follows from (3.66) that $(\delta s(0)/\delta \eta^A(T)) > 0$. The migrant who want to accumulate a stock of human capital higher than the one he would accumulate anyway will invest a higher fraction of human capital into further production in $t = 0$. However, since the second term in (3.66) is negative and increasing over time, this difference will diminish.

Appendix 4: The Sufficient Conditions

It remains to show that the necessary conditions are also sufficient for an optimum. While the standard approach in a fixed time problem to show optimality of an admissible pair,[31] that satisfy the necessary conditions, is to verify that the Hamiltonian exhibits certain concavity properties,[32], the construction of sufficiency conditions is more difficult for free final time control problems. A sufficiency theorem for free final time problem is provided by Seierstad (1984-b). The basic idea is to require a pair (x^*, u^*) not only to be optimal for one specific t, but to maximize the value function among all optimal fixed final time solutions over the period considered. However, such sufficiency conditions are likewise not applicable to minimal time problems. An admissible pair for a minimal time problem is optimal if there exists no other admissible pair, fulfilling the necessary conditions and the target conditions (i.e. some endpoint restrictions on the state variables) in a shorter time period and if the above mentioned concavity properties of the corresponding fixed time horizon problem are fulfilled. While the latter can be proved quite easily by employing the standard concavity conditions for the Hamiltonian, it is quite difficult to find general conditions to ensure the former requirement. A sufficiency theorem is provided by Seierstad (1984-a) (see also Seierstad and Sydsaeter (1987)). Although the condition imposed on the optimal solution is rather restrictive and it's formulation not intuitively obvious, it seems applicable for the above maximization problem. The intuition of the condition will be given below. It will then be shown that the condition holds for the problem on hand.

Consider a minimal time problem, with x, λ, u being vectors of state- costate- and control variables, respectively. Assume that an admissible pair $(x^*(t), u^*(t))$, defined on the interval $[0, T]$, satisfies the fixed final time sufficient condition for some adjoint function $\lambda(t)$. It follows that[33]

$$\int_0^T f^0(x^*(\tau), u^*(\tau))d\tau - \int_0^T f^0(x(\tau), u(\tau))d\tau = \Delta \geq \lambda^*(t)(x(T) - x^*(T)) \qquad (3.67)$$

where $f^0(.)$ is the objective function and $(x(t), u(t))$ is any admissible pair. Note that, in a minimal time problem, $\Delta = 0$. Since a minimal time problem is only meaningful if at least one state variable has to hit a certain target, assume the endpoint restriction $x(t) \geq \bar{x}$, with

[31] Let x be a vector of state- and u be a vector of control variables. An admissible pair (x, u) is one which satisfies the system of differential equations for the state variables, any boundary conditions on the control variables and the endpoint restrictions on the state variables.

[32] Mangasarian (1966) shows that the necessary conditions are also sufficient if the Hamiltonian is concave in state- and control variables. Arrow and Kurz (1970) proposed a generalization of the Mangasarian result. They show that it is sufficient that the Hamiltonian, maximized with respect to the control variables, is concave in the state variables.

[33] This result is derived in Seierstad and Sydsaeter (1977).

$\bar{x} > x(0)$ and t the optimal endpoint. From the transversality conditions it follows for the optimal solution specified above:

$$(x^*(T) - \bar{x})\lambda^*(T) = 0 \tag{3.68}$$

For $\lambda(T) \neq 0$, it follows that $x^*(T) = \bar{x}$. Now, assume there exists a t', with $t' < T$ and $x(t') \geq \bar{x}$. Let the corresponding pair $(\tilde{x}, \tilde{u})$ be defined on $[t', T]$. The core idea of the sufficiency condition provided by Seierstad (1984-a) is now to show that, if (x^*, u^*) fulfills the sufficient condition for the fixed time horizon problem with endpoint T, there exists no pair $(\tilde{x}, \tilde{u})$ for which $\tilde{x}(t') \geq \bar{x}$, with $t' < T$.

This is ensured if the pair $(\tilde{x}, \tilde{u})$, defined on $[t', T]$, has the property that:

$$\dot{\tilde{x}}(\tau)\lambda^*(T) \geq 0, \qquad \tau \in (t', T) \tag{3.69}$$

with strict inequality in at least one τ. To see this, note that $\int_{t'}^{T} \dot{\tilde{x}}(\tau)\lambda^*(T) = \tilde{x}(T)\lambda^*(T) - \tilde{x}(t')\lambda^*(T) > 0$. Consequently, $\tilde{x}(T) > \bar{x}$. Furthermore, for $\lambda^*(T) \neq 0$, $x^*(T) = \bar{x}$. Accordingly, it follows that $\lambda^*(T)(\tilde{x}(T) - x^*(T)) > 0$, which contradicts (3.67). As a result one can state that, if the pair (x^*, u^*) fulfills the fixed time sufficient conditions for an optimum on $[0, T]$ and if (3.69) is fulfilled $\forall t' \in [0, T]$, then (x^*, u^*) is optimal.

Applied to the problem above, sufficiency of a solution defined on the interval $[0, T]$ is ensured if the optimal pair of control- and state variables fulfills the necessary conditions and if the Hamiltonian, maximized with respect to the control, is concave in the state variables (Arrow and Kurz (1970)). For the control s^* fulfilling conditions (3.6), (3.7), and (3.9), the quadratic form of the Hamiltonian is given by:

$$d^2\hat{\mathcal{H}} = -\lambda_1\gamma_1 G''(.)dH^2 \tag{3.70}$$

Consequently, the Hamiltonian, maximized with respect to the control variables is either concave or strictly concave, depending on whether the integration function is linear or decreasing in the stock of human capital, H, respectively. The solution $[A^*, H^*, s^*, T]$, fulfilling the necessary conditions, with $A^* \geq \bar{A}$, is accordingly optimal in the fixed final time problem defined on $[0, T]$. It remains to check whether condition (3.69) holds for all $t' \in [0, T]$. The target of the problem is to require that $A(T) \geq \bar{A}$, with $H(T)$ free. It follows that $\lambda^*(T) = \lambda_1(T)$. Now, for any $t' \in [0, T]$, expression (3.69) is given for the problem on hand:

$$\lambda^*(T)\,\dot{A}(\tau)\,, \qquad \text{with } \tau \in (t', T) \tag{3.71}$$

Let $A(t') \geq \bar{A}$. From the optimality conditions it follows that $s(t') = 0$ and, consequently, $s(\tau) = 0$, $\forall \tau \in (t', T)$. Therefore:

$$\dot{A}(\tau) = \tau A(\tau) + wH(\tau) - \gamma_0 - \gamma_1 G(H(\tau)) > 0 \quad \forall \tau \in (t', T) \tag{3.72}$$

(3.71) implies that $A(T) > A^*(T) \geq \bar{A}$. It is directly obvious from the above explanations that this contradicts the sufficiency conditions for the fixed final time problem. Consequently, the solution $(A^*(T), H^*(T), s^*(T), T)$ is optimal.

3.7 Figures

FIG.1: TOTAL INVESTMENT.

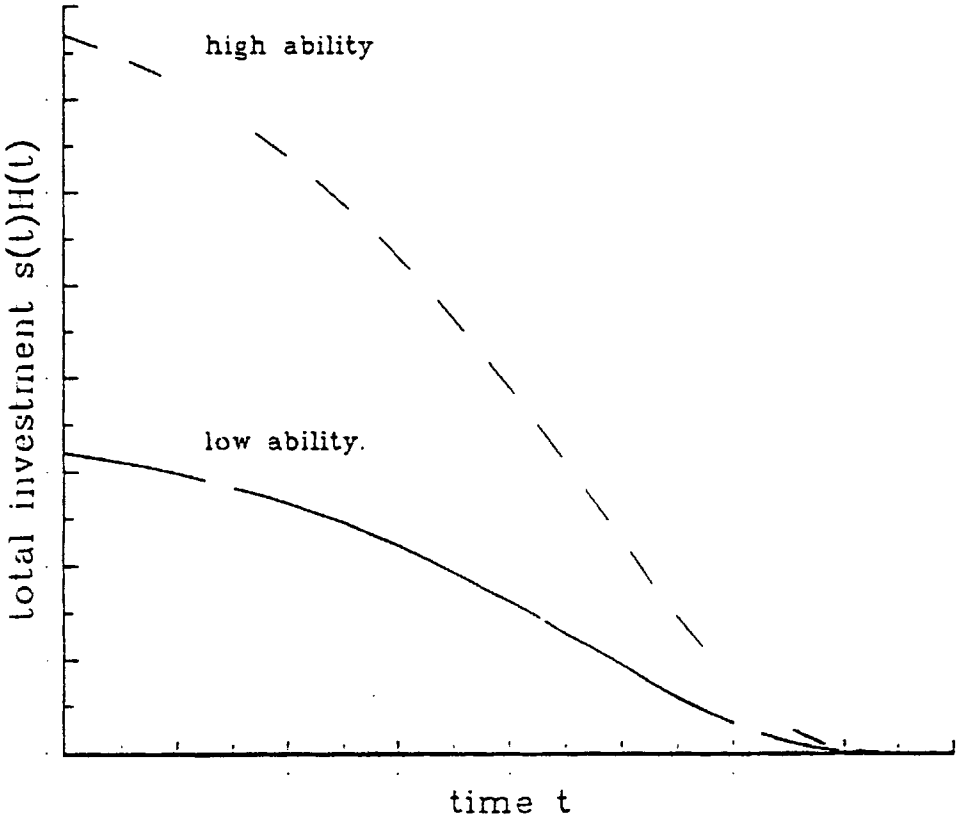


FIG.2: HUMAN CAPITAL

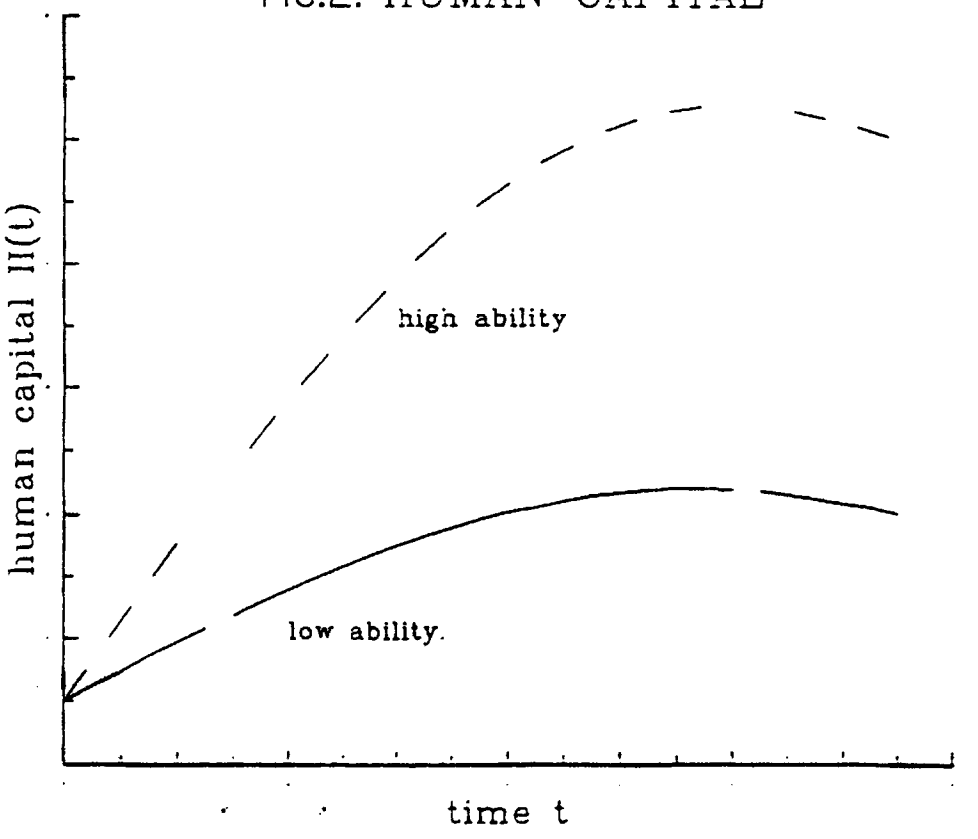


FIG.3: MEASURED EARNINGS

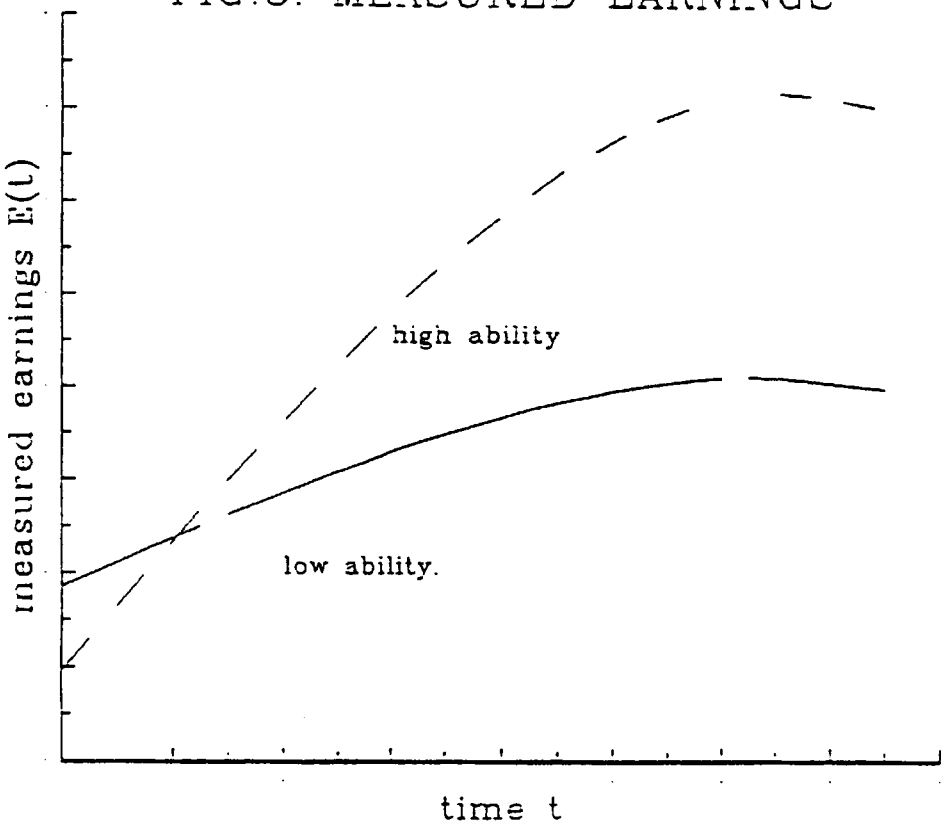


FIG.4: FRACTION INVESTED

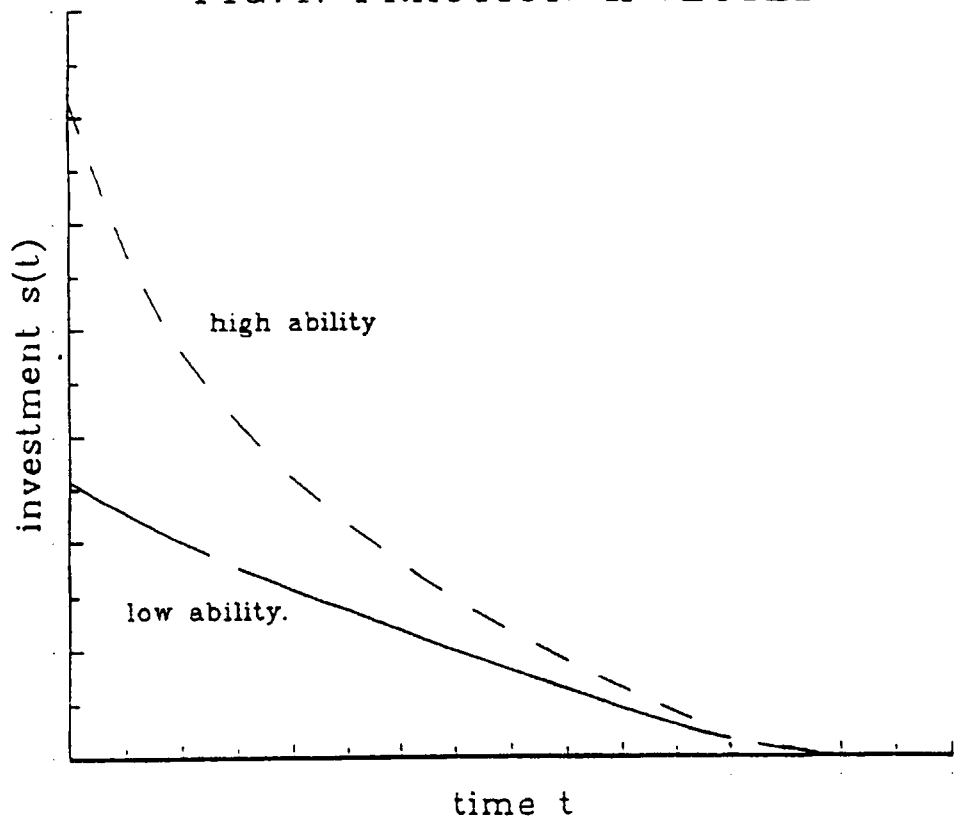


FIG.5: HUMAN CAPITAL

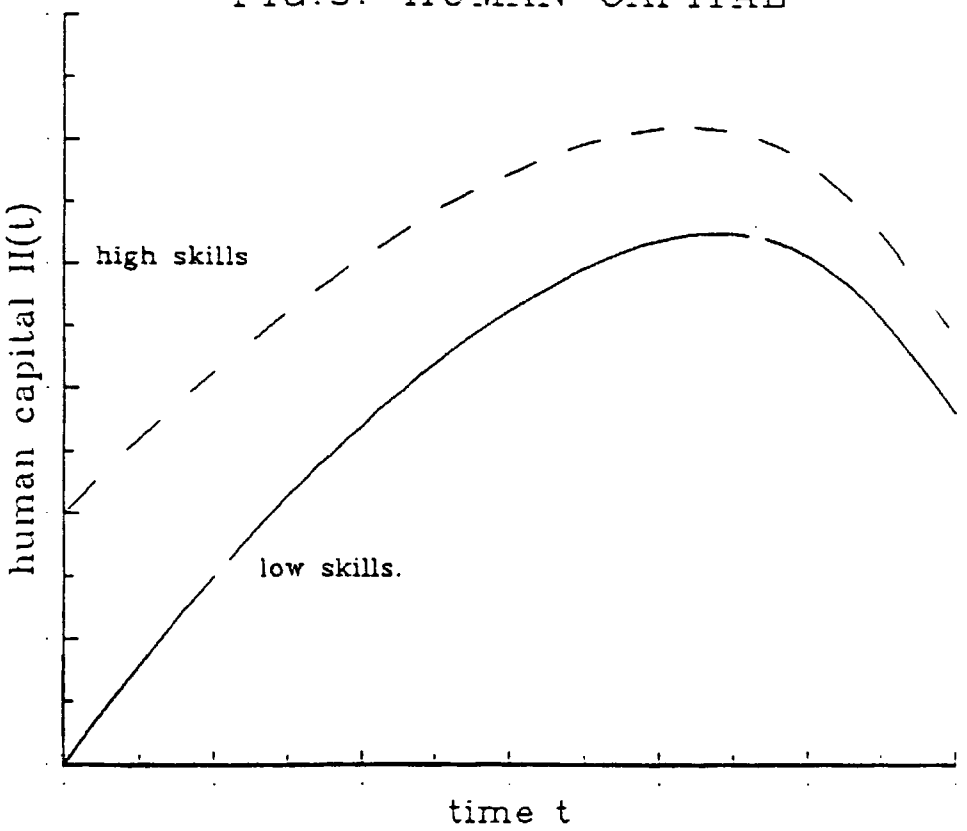


FIG.6: FRACTION INVESTED

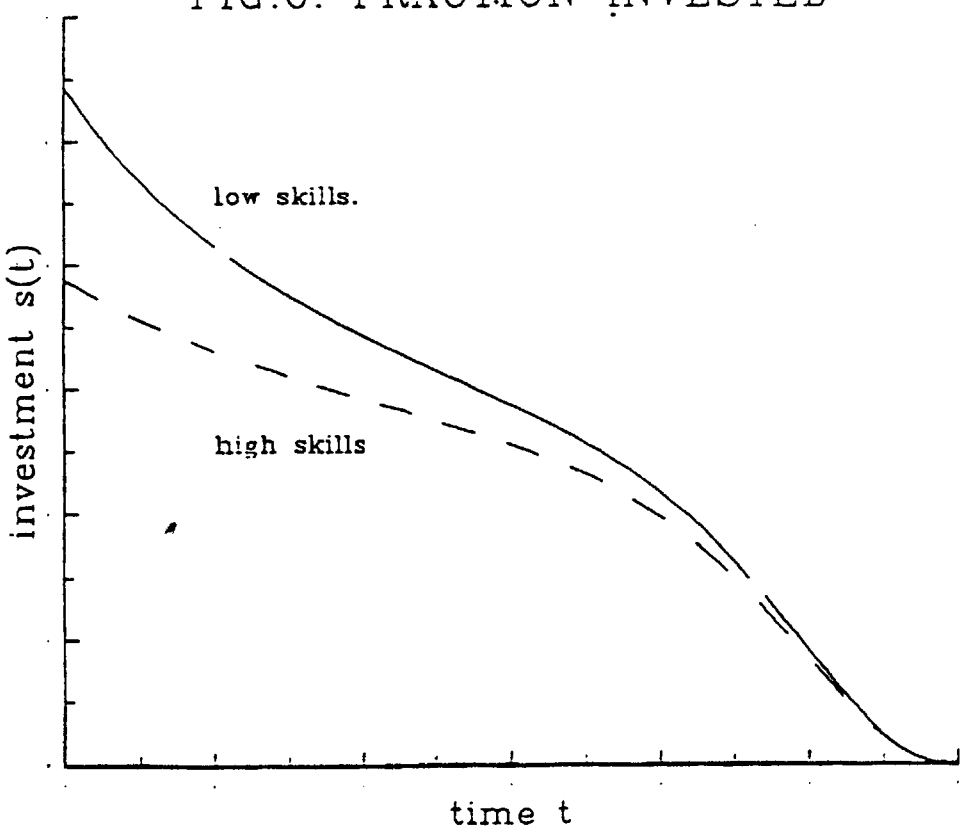


FIG.7: MEASURED EARNINGS

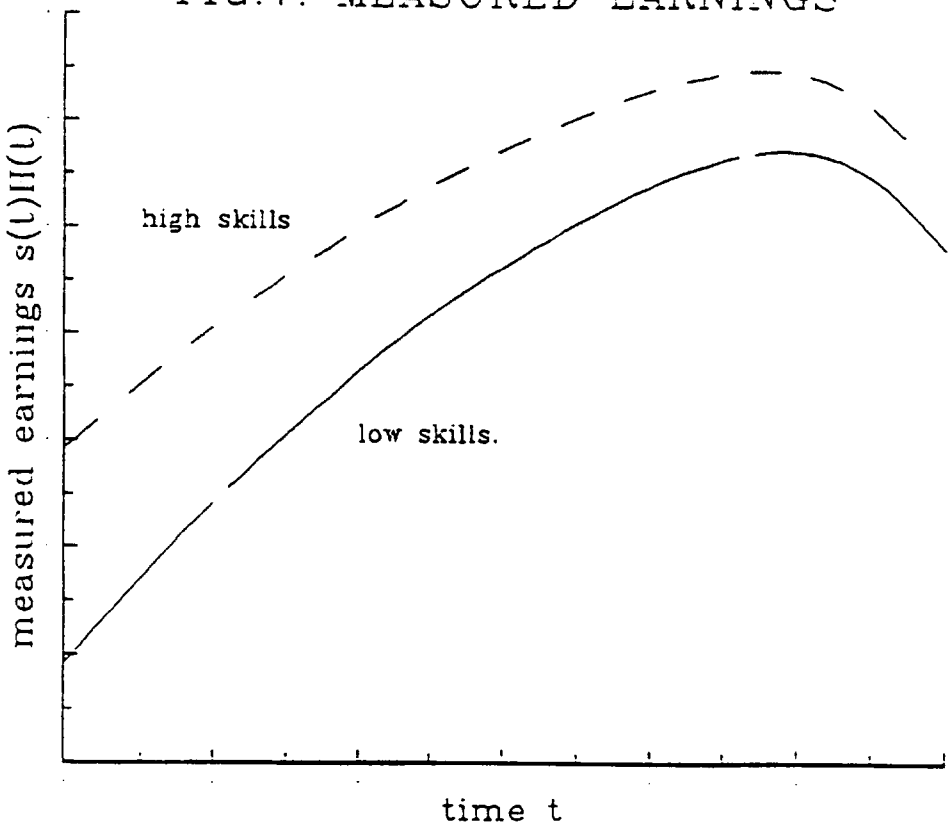


FIG.8: SHADOW PRICE

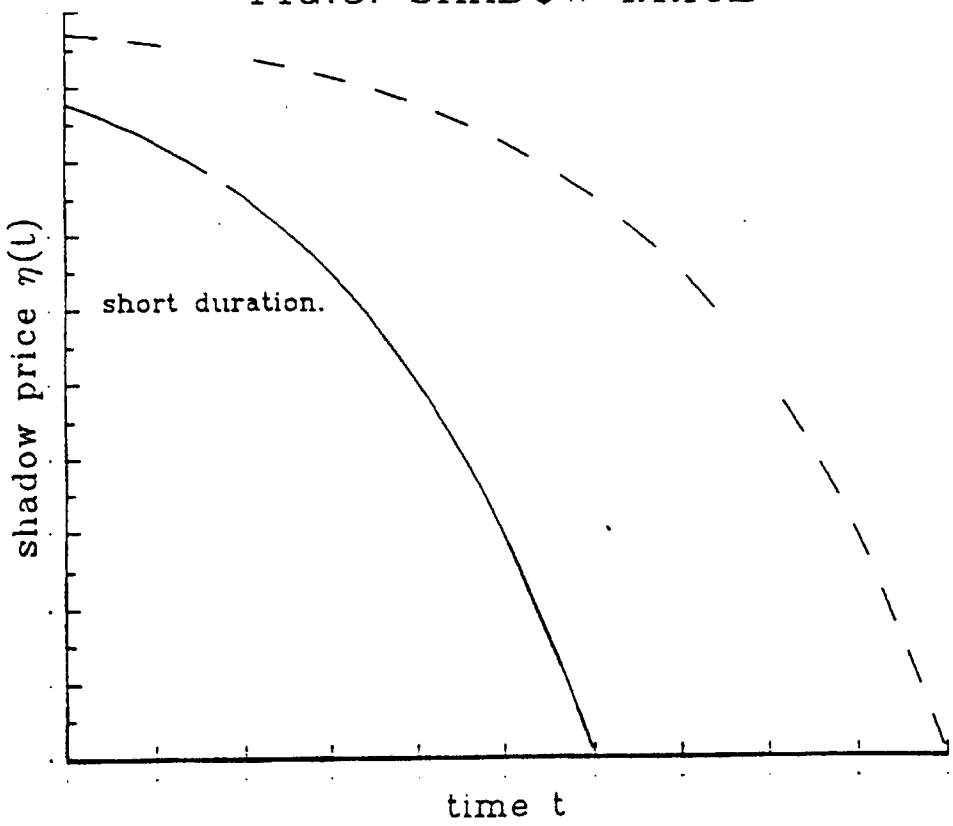


FIG.9: MEASURED EARNINGS

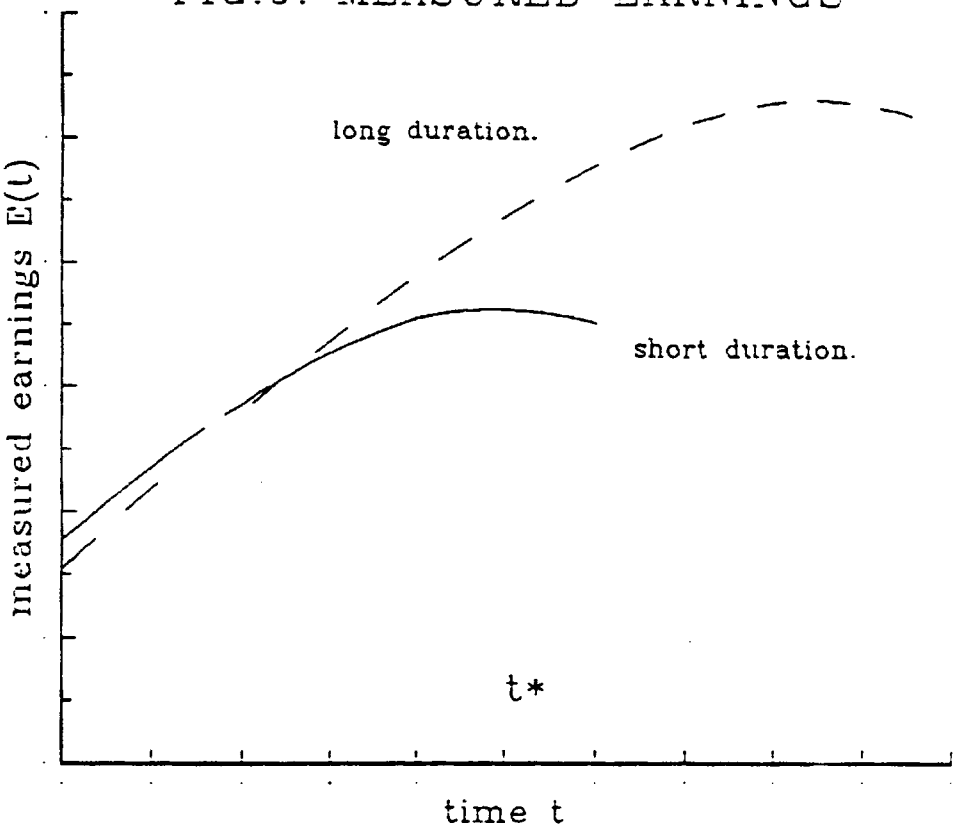


FIG.10: SHADOW PRICE

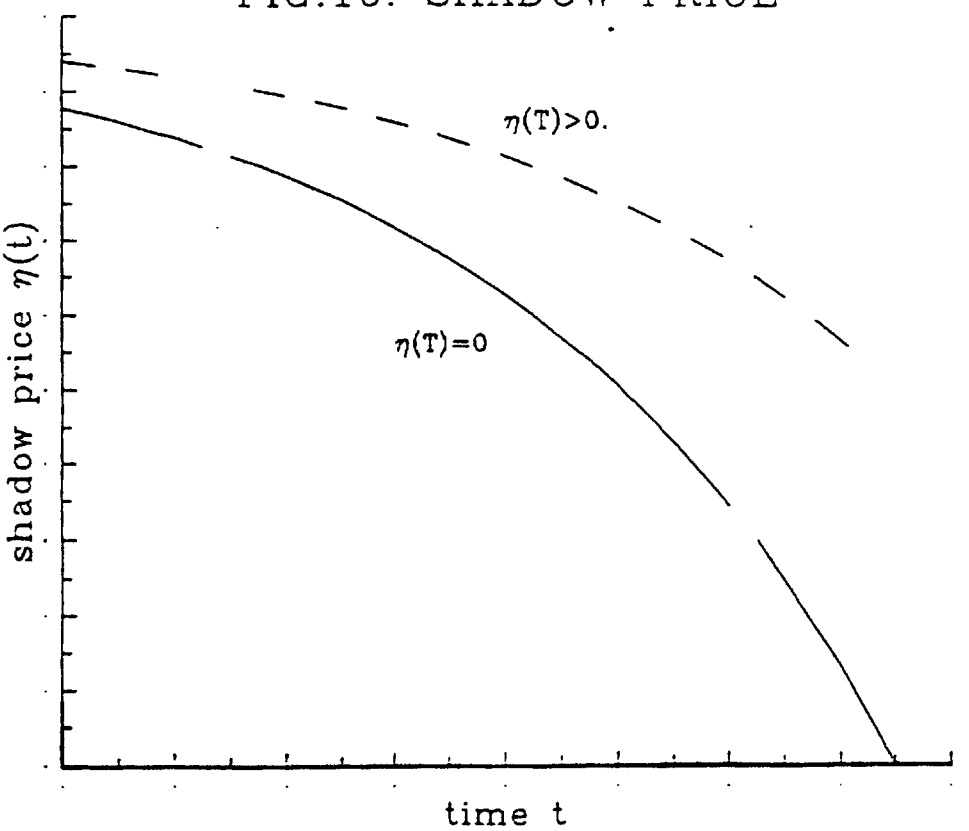


FIG.11: MEASURED EARNINGS

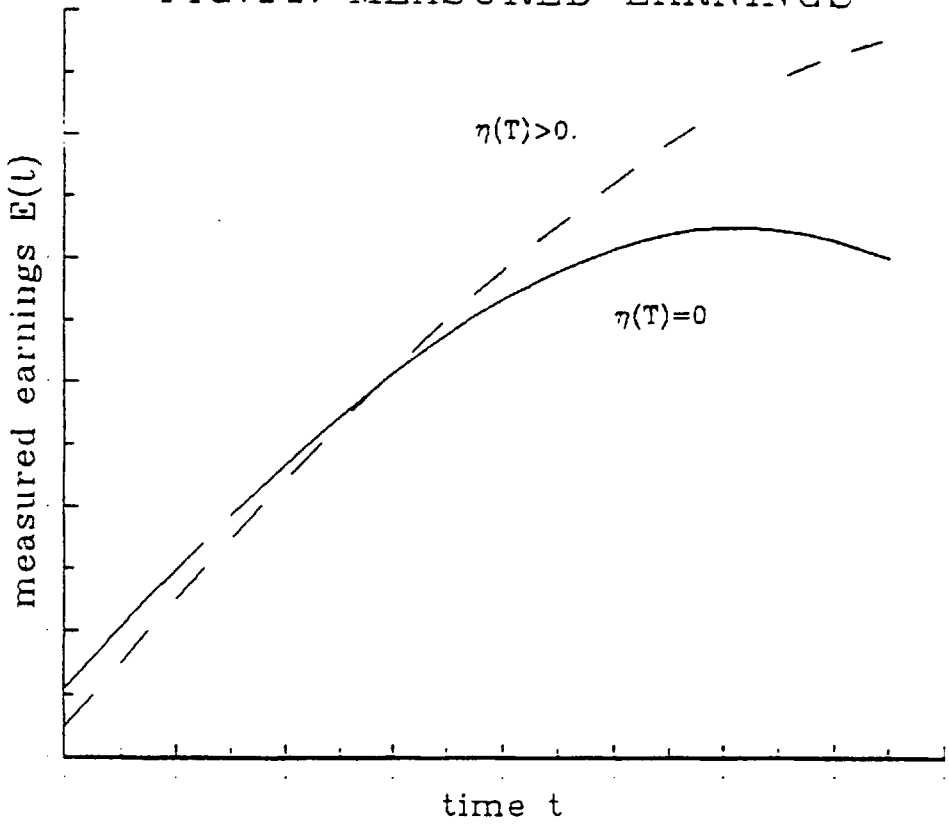
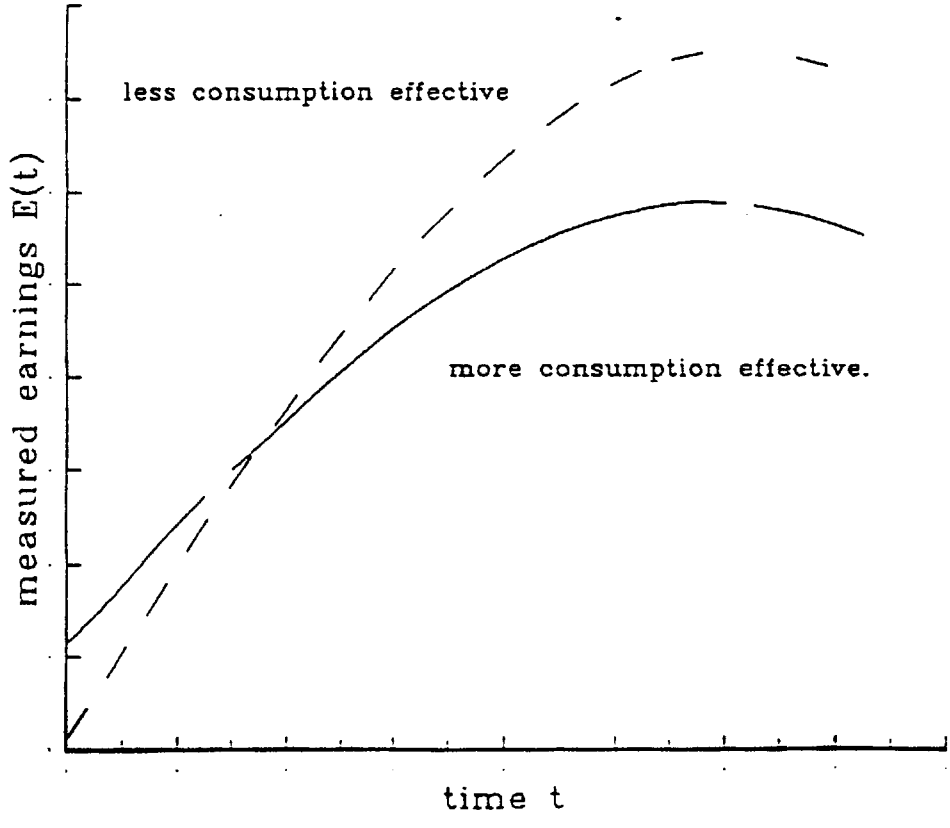


FIG.12: MEASURED EARNINGS



Chapter 4

Migration, Savings and Uncertainty

4.1 Introduction

A major form of intra-European migration and migration into Europe, but also of intra-Asian migration and migration between Asia and countries of the Middle East, is "guest worker", or, more generally, return migration. The impact of this form of migration on the economies of both the labor-exporting country and the labor-importing country differs in many aspects from that of permanent migration. In contrast to permanent migrants, temporary migrants invest a large proportion of their earnings either into savings in the host country, or they transfer it to their home country, where it is then saved or used to support family members. Both the amounts of money that are transferred back home and that are saved in the host country have important implications for the economies considered. For the emigration country, transferred money is a major balance of payment support.[1] For the immigration country, transfers contribute largely to the balance of payments deficit.[2] On the other side, savings

[1]In 1973, transfers from Turkish and Yugoslav workers in Germany amounted to over twice the total exchange obtained through exports of goods from these countries to Germany (Hiemenz and Schatz, 1979, p.1). Over the period from 1960 to 1984, transfers of Greek workers from Germany to Greece amounted to 16% of Greece's capital goods exports over that period (Glytsos, 1988, p.525). Transfers from Thai workers in the Middle East in 1981 were equivalent to about 6% of the total value of exports from Thailand in that year (Pitayanon, 1986, p.273). Remittances of Pakistanis from the Middle East finance some 86% of Pakistan's trade deficit (Robinson (1986)).

[2]For instance, transfers of migrant workers from Germany to their home countries amounted to 40% of the total deficit of the German account of services and transfers with foreign countries (Monatsberichte der deutschen Bundesbank, 1974, p.22).

of migrants in the host country provide a substantial part of the domestic savings of immigration countries and contribute to their capital formation (Macmillan, 1982, p.251)[3].

Despite the importance of migrant's consumption- and savings behavior, there has been surprisingly little theoretical research on this topic. One difficulty when dealing with this subject is that earnings not used for consumption in the host country are not necessarily saved; they are partly used to support family members in the home countries. On the other side, earnings that are transferred to the home countries are not entirely consumed, but to a large part invested into savings. There is a confusing use of concepts in the literature: While official data usually refer to all foreign exchange of migrants to the home countries as *remittances*, it would be wrong to conclude that all such transfers are completely consumed by family members. A large part of these transfers are saved in the home countries.[4] On the other side, it would be similarly wrong to interpret all earnings that are not consumed as savings, since a part of it is used for the support of family members. Following Paine (1974), *remittances* will here be used in the more narrow sense of earnings that are used to support family members. Savings are then all earnings that are saved at home and abroad[5]. The strict differentiation of income that is not consumed in the host country into savings and remittances is important for analytical purposes. While remittances are best analyzed in a family context (see, e.g., Lucas and Stark (1985)), for the analysis of savings behavior an individual approach seems more appropriate.

One aim of this study is to explain why migrant workers have a different savings behavior than native workers. The analysis isolates two motives which are likely to explain to some degree differences in the savings rates of migrants and natives: life cycle motives and precautionary motives. The extent to which life cycle motives account for the excess savings of migrants, relative to comparable native workers, is shown to depend on the wage differential and the relative price level between host- and home country, the migrant's preference for consumption at home, and the desired length of migration. The analysis further reveals that the extent to which precautionary savings

[3]Jones and Smith (1970) report that the local savings rate (earnings that are invested into savings in the host country) of migrant workers in Great Britain in 1965 was about 2% above UK average. For France, the average local savings of foreign workers in 1970 was 50% higher than those of a French person with the same income (Granier and Marciano, 1975).

[4]Monatsberichte der deutschen Bundesbank, 1974, p. 275

[5]According to Paine (1974, p. 103), only survey data allow for such a differentiation. For Turkish workers abroad, Paine calculates for 1971 an average saving rate of 36% of total income. A further 11% was used to support family members. These numbers indicate that savings net of remittances are still surprisingly high.

of migrants are higher than those of comparable natives depends on the migrant's utility structure, the perceived degree of risk of the labor markets of host- and home country and the correlation between the effects of some events on the economies considered.

A further focus of the analysis is the impact of uncertainty about future income streams in both, host- and home country, on the desired length of migration and, in the limit, on the migration decision itself. The results show that no general conclusions are possible. Contrasted with a certain environment, uncertainty influences the migrant's choice. However, it's effect depends not only in size, but also in sign on the migrant's utility structure, on the riskiness of the host country labor market, relative to that of the home country, and on interdependencies between the effects of external shocks on both economies.

The next section will first introduce the theoretical framework. It will then be shown how the wage differences in home- and host country, preferences for consumption at home as well as uncertainty with respect to future earnings may influence the migrant's savings behavior. As a point of reference, migrant's savings behavior will be compared with that of native workers. The second part of the analysis concerns the impact of uncertainty on the migrant's decision to migrate and on the length of his stay abroad. Results are then illustrated with a numerical example.

4.2 Saving and Migration Decisions

Let the migrant worker be confronted with the following decision problem: At some point in time, he has to decide whether he wants to migrate to a potential host country and for how long. He further has to decide about his future path of consumption. An important motive for migration would be a higher rental rate on a unit of human capital stock in the potential immigration country. The worker would then migrate when the economic advantages of doing so outweigh the cost of migration, or, following Sjaastad (1962), when the present value of the migration decision is positive. This is also the classical explanation for labor mobility: As Hicks (1932, p.76) pointed out, "...differences in economic advantages, chiefly differences in wages, are the main causes of migration." However, it implies that the worker's objective is only to maximize lifetime income: his decision would solely be influenced by monetary aspects. Should this be the case, and once having decided to migrate, is there any reason for the worker to return to his home country? In other words, is such a simple model capable to explain temporary migration? Obviously not, or only under certain assumptions on the process of human capital accumulation, and the evaluation of human capital, in

both countries.[6]

A simple extension of the model would be to let the potential migrant maximize lifetime utility from consumption, given a lifetime budget constraint that depends on the migration decision. When the migrant prefers to consume at home than abroad (because of other arguments that are complementary to consumption, like being together with his family and friends, living in a used environment, enjoying the climate etc.), his optimal decision may now be to migrate only *temporarily*, although the value of the stock of his human capital is higher abroad.[7] The reason for this is that, since his lifetime is finite, each unit of time spent abroad increases his lifetime utility by raising his total consumption possibilities, but it decreases lifetime utility by reducing the time available for consumption at home.

4.2.1 The Basic Model

Let the lifetime horizon of the migrant be equal to $T = 1$ and assume, for simplicity, that the worker is productive over his entire life cycle. The migrant will have to choose the time t he wants to stay in the host country, thereby determining the time $(1 - t)$ he will afterwards stay in his home country. The migrant's objective is to maximize utility from consumption. Let his lifetime utility function be additively separable with respect to home- and host country consumption, with the subutility functions being increasing in consumption, strictly concave and continuously differentiable. Assume that the rate of time preference and the interest rate are both equal to zero. This does not change any qualitative results of the analysis that follows, but it implies that the flows of consumption in host- and home country are both constant. The migrant's lifetime utility may be expressed in the following simple form:

$$V(c^I, c^E) = t\,u^I(c^I) + (1 - t)u^E(c^E) \tag{4.1}$$

where u^I and u^E are the subutility functions in the immigration- and the emigration country[8], and c^I and c^E are the respective constant flows of consumption. A higher preference for consumption at home corresponds to a higher marginal utility from consuming an equal consumption flow k in the home country: $u'^E(k) > u'^I(k)$.[9]

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[6]This is outlined in Appendix 2.

[7]The trade off between higher wages in the host country on the one side, and a higher preference for consumption at home on the other side was firstly formalized by Djajic and Milboune (1988).

[8]Immigration- and emigration country will be alternatively referred to as host- and home county.

[9]$u^I(c^I)$ and $u^E(c^E)$ could likewise be expressed as $u(c^I, G)$ and $u(c^E, F)$, where G and F are indices, representing environmental factors like family, friends etc. When G and F are complementary to c^I

Total future earnings in host- and home country are given by $y^I(t,x)$ and $y^E(t,z)$, where x and z are random variables with known joint density function $f(x,z)$. These random variables could be interpreted as indices which reflect the impact of uncertainty on future incomes in host- and home country.[10] The variances of x and z will be denoted by σ_x^2 and σ_z^2, respectively, and the covariance between both by σ_{xz}. The following assumptions seem to be natural:

$$y_t^I > 0; \quad y_t^E < 0; \quad y_x^I > 0; \quad y_z^E > 0 \tag{4.2}$$

This simply implies that total earnings accumulated in either country are the higher the longer the migrant will stay.[11] If interpreting x and y as indices of labor market conditions, the signs of the last two terms are self explaining: the more favorable the state of the world, the higher will be total earnings, keeping t constant.

The migrant's budget constraint is then given by the following expression:

$$t\,p\,c^I + [1-t]\,c^E + \eta = y^I(t,x) + y^E(t,z) \tag{4.3}$$

where p is the price level in the host country, relative to that in the home country, and η are fixed costs of migration. Rewriting (4.3) yields:

$$c^E = \frac{1}{1-t}\,[y^I(t,x) + y^E(t,z) - \eta - t\,p\,c^I] \tag{4.4}$$

Inserting (4.4) into (4.1) and adopting the von Neumann - Morgenstern hypothesis of expected utility maximization, the individual will solve the following problem:

$$\phi(c^I,t) = \max_{t,c^I} E(V(c^I,c^E)) \tag{4.5}$$

Accordingly, the migrant will choose the level of consumption abroad, c^I, and the time t to stay in the host country so as to maximize expected lifetime utility.

Since any uncertainty will not be resolved before t and c^I are chosen, the following restriction has to be imposed on the migrant's total consumption in the host country:

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and c^E, respectively, (in the sense of Pareto and Edgeworth, see Hicks (1979), p.44), and if additionally $F > G$, then $u'^E(k,G) > u'^I(k,F)$. For simplicity, the indices G and F are suppressed here.

[10] For instance, when risk affects income in a multiplicative form, then $y^I = \bar{y}^I(t)\,x$ and $y^E = \bar{y^E}(t)\,z$, where $\bar{y}^I$ and $\bar{y^E}$ are total incomes in home- and host country as functions of t.

[11] Because lifetime is finite and t signifies the time being in the host country, an increase in t will increase $y^I(.)$, but it will decrease $y^E(.)$, since less time is available for the accumulation of earnings at home.

$$t\,p\,c^I \leq [y^I(t,\underline{x}) + y^E(t,\underline{z}) - \eta] \tag{4.6}$$

where $\underline{x}$ and $\underline{z}$ are the minimum levels of x and z. Relation (4.6) simply states that total consumption in the host country has to be lower than total lifetime earnings when the most unfavorable states of the world should realize.

The first order conditions for an interior maximum are given by:

$$\phi_t = E[u^I(c^I) - u^E(c^E)] + E\left[u'^E(c^E)\frac{dc^E}{dt}[1-t]\right] = 0 \tag{4.7-a}$$

$$\phi_{c^I} = E[u'^I(c^I) - p\,u'^E(c^E)] = 0 \tag{4.7-b}$$

Relation (4.7-a) implicitly determines the optimal length of stay in the immigration country. The optimal t will be chosen so as to equalize the expected marginal loss in overall utility of staying one unit of time longer in the host country with the expected marginal gain of staying one unit longer abroad, both measured in units of utility.

Expression (4.7-b) simply states that the expected marginal rate of substitution between consumption at home and abroad has to equal the relative price level.

Type 1 and *Type 2* Uncertainty

Income uncertainty that affects the migrant's decision problem may be due to unforeseeable future events that influence labor markets, and therefore earnings, of host- and source country. It may also be due to imperfect knowledge about the labor market conditions in the host country. Both types of uncertainty have different characteristics and may have different consequences for the migrant's decisions. The first kind of uncertainty will further be referred to as *type 1* uncertainty. The latter type is denoted as *type 2* uncertainty. The analysis below relates solely to *type 1* uncertainty. Implications of *type 2* uncertainty will be pointed out later.

Some examples for *type 1* uncertainty would be unforeseeable changes in raw material prices, like an oil crisis, wars, worldwide economic downturns, political unrest etc. For this type of uncertainty, it seems appropriate to assume that, the longer the migrant intends to stay in either country, the stronger will be the impact of some shock on his total income to be accumulated in that country. Formally, this can be expressed by assuming that $y^I_{tz} > 0$ and $y^E_{tz} < 0$.[12] In other words, marginal total income at home

[12]Note again that an increase in t decreases the time being in the home country, so that $y_t < 0$.

and abroad, which are earnings per unit of time, increase in x and z respectively.[13] This is what Levhari and Weiss (1974) call *increasing risk* and implies that the variability of total income, accumulated in either country, increases with the time being in that country. Increasing risk would correspond to a multiplicative specification of the effect of uncertainty on earnings, as it is usually assumed in the literature on uncertainty and investment into human capital (see, for example, Eaton and Rosen (1980), Kodde (1986)).

The Deterministic Case

Reconsider the migrant's optimization problem in a deterministic world. Assume, therefore, that x and z are known to be equal to their expected values: $x = E(x) = \tilde{x}$ and $z = E(z) = \tilde{z}$. It then follows for (4.7-a) and (4.7-b):

$$[u^E(c^E) - u^I(c^I)] = \left[u'^E(c^E)\frac{dc^E}{dt}[1-t]\right] \tag{4.8-a}$$

$$u'^I(c^I) = p\,u'^E(c^E) \tag{4.8-b}$$

The system (4.8-a), (4.8-b) determines the optimal time to be spent abroad, t^0, and the optimal level of consumption in the host country, c^{I0}. For an equal price level in both countries ($p = 1$), and expressing a higher preference for consumption at home by a higher marginal utility of a constant flow of consumption k in the home country, $u'^E(k) > u'^I(k)$, it follows from (4.8-b) that the optimal level of consumption at home is higher than the optimal level of consumption abroad: $c^{E0} > c^{I0}$. Throughout the analysis, it will be assumed that the migrant has a higher preference for consumption at home, which ensures an interior solution for the time spent abroad (corresponding to temporary migration). It follows then from (4.8-a) that he will decide to migrate when the increase in lifetime utility from staying one unit longer abroad is at least as high as the decrease in lifetime utility by being deprived of the possibility to consume during this unit of time at home.

For completeness, consider the case where the migrant is indifferent between consumption at home and abroad. This would correspond to $u'^I(k)$ being equal to $u'^E(k)$, and, consequently, $c^{I0} = c^{E0}$ and $u^I(c^{I0}) = u^E(c^{E0})$. The migrant's decision will now depend solely on earnings prospects at home and abroad – the classical explanation for migration. For an equal price level in both countries ($p = 1$), and indifference between consumption at home and abroad, (4.8-a) reduces to

[13] This includes the possibility of unemployment. Marginal total income would then correspond to eventual unemployment benefits.

$$u'^{E}(c^{E})\,[y_t^I + y_t^E] = 0 \tag{4.9}$$

Migration may now be permanent, temporary, or the migrant may be indifferent between migrating or not migrating, depending on whether, for all $t \in (0,1)$, $(y_t^I + y_t^E) > 0$, $(y_t^I + y_t^E) < 0$, or $(y_t^I + y_t^E) = 0$, respectively. An interior solution evolves when there exists a t^0, $t^0 \in [0,1]$, for which $(y_t^I + y_t^E) = 0$. In Appendix 2 it is shown that this may well be the case when human capital, accumulated in the host country, is only earnings effective in the home country. In this special case, temporary migration may evolve in a deterministic environment, although the migrant is indifferent between consumption in either country and although he bases his decision on purely monetary criteria.

4.2.2 Savings of Migrants and Natives

There are a variety of explanations why individuals accumulate savings. People may save because life time profiles of income and desired consumption do not coincide. Savings are thus a means to transfer consumption over time. Savings of this kind are said to be due to life cycle motives. A further reason to save are precautionary motives. Precautionary savings are induced by uncertainty about future income streams. Individuals save to have funds for future contingencies. Savings may also be due to bequest motives. Savings would here be a means to provide capital for children or other heirs.

The following analysis will concentrate on the first two motives. It will be shown that both, savings that are due to life cycle motives, and savings that are due to precautionary motives, may differ considerably between migrant workers and comparable natives.

Life Cycle Motives

In simple intertemporal models, savings that are referred to as life cycle savings occur when the individual's rate of time preference differs from the interest rate. Individuals save or desave, depending on whether the rate of time preference is smaller or larger than the interest rate. In the present model framework, the interest rate and the rate of time preference are both assumed to be equal to zero. Accordingly, there is no difference between both rates which could induce savings. Since the purpose is to compare savings of migrants and natives, this restriction translates into the assumption that savings induced by such a difference are equal between migrants and natives. What remains are life cycle savings that accrue because profiles of lifetime income differ from

profiles of lifetime consumption. It will be shown that this may be major reason why migrants have a different savings behavior than native workers.

Consider a migrant worker who's decision problem is characterized by the above optimization problem. His earnings prospects abroad are higher than those at home. However, he prefers to consume at home rather than abroad. His savings in the host country that are due to life cycle motives consist then of two components: first, holding the flow of consumption constant over the life cycle, he will save because earnings are higher abroad than at home. Secondly, holding the income stream constant over the life cycle, he will save because desired consumption is higher at home than abroad.

Before formalizing these arguments, a native reference group has to be characterized. Define therefore a *comparable* native as one who maximizes lifetime utility over the same horizon T and who has the same path of human capital accumulation as the migrant worker. Furthermore, since the native lives in his home country, let his lifetime utility function be equal to the subutility function of the migrant worker in the emigration country. Assume, for simplicity, that both migrant and native have a constant stock of human capital over the horizon T. Denote earnings per unit of time in the emigration- and the immigration country by w^E and w^I, respectively, with $w^E < w^I$. Accordingly, migrant and native receive equal earnings in the immigration country. The total savings rate s is given by:

$$s = \frac{w^I - c^I}{w^I}$$

How would this savings rate differ between native and migrant, when both were observed at the same point in time during the migrant's stay abroad? The lifetime budget constraint of the native worker corresponds to $t\,w^I + [1-t]\,w^I = c^I$. Given his utility function $V^N = t\,u^I(c^I) + [1-t]\,u^I(c^I)$, he will choose a constant c^I over his life cycle that is equal to w^I. Consequently, his savings rate is equal to zero.[14]

The migrant's budget constraint is, according to (4.3), given by $t\,w^I + [1-t]\,w^E = t\,c^I + [1-t]\,c^E$. Neglect any fixed costs of migration ($\eta = 0$). The migrant's savings rate s^M consists then of two components, savings that are due to discontinuities in his life cycle income stream (s_1^M) and savings that are due to discontinuities in his stream of desired consumption (s_2^M):

$$s^M = s_1^M + s_2^M = \frac{w^I - w^E}{w^I}[1-t] + \frac{c^E - c^I}{w^I}[1-t] = \frac{w^I - c^I}{w^I} \qquad (4.10)$$

[14]Remember that savings that are due to differences in interest rate and rate of time preferences are excluded by assumption.

The rate s_1^M is positive whenever $w^I > w^E$: in this case, future earnings will decrease. Life cycle earnings of the migrant are lower than those of the comparable native, although they both have equal earnings in the immigration country. The prospect of lower future earnings would then induce the migrant to accumulate savings.[15] The share of s_1^M in the total savings rate depends on the size of the wage differential and on the length of the desired migration period.

Additionally, migrants may save because they have a preference for consumption at home. The corresponding savings rate is given by s_2^M. Savings are accumulated to allow for an increase in the flow of consumption upon return. The share of s_2^M in the total savings rate depends on the extent of migrant's preference for consumption at home and, again, on the length of the time abroad. The size of s_2^M depends additionally on the price level abroad. Should the price level be higher in the immigration country than in the emigration country ($p > 1$), it follows from (4.8-b) that the migrant would further reduce consumption abroad, relative to consumption at home. Consequently, a higher price level in the immigration country would reinforce the size of s_2^M.

Consequently, when migration is intended to be temporary,[16] life cycle motives may induce migrant workers to have savings rates that are higher than those of comparable native workers. The total rate of savings of a migrant worker is the higher, the larger the differential between wages at home and abroad, the stronger the preference for consumption at home and the higher the relative price level abroad. The savings rate decreases with the length of migration.

Precautionary Motives

The second explanation for a different savings behavior between migrants and natives are precautionary motives. In what follows, the migrant's optimal savings- and consumption decision in the host country under small uncertainty about future income will first be compared with that under certainty. It is then shown that precautionary savings of migrant workers are likely to be higher than those of comparable native workers.

Let t^0 and c^{I0} be the optimal length of stay and the optimal level of consumption

[15]This is essentially the motive for savings that is analyzed by Galor and Stark (1990). For wages being lower in the home country, Galor and Stark illustrate in a two-period model that migrants savings in the first period are the higher, the higher their return probability in the second period.

[16]The analysis would also include the case where migration is desired permanent (because a preference for consumption abroad), but is restricted being temporary (because legal restrictions, like e.g. in Switzerland). In this case, s_2^M would be negative.

in the host country, when x and z are known to be equal to their expected values $\tilde{x} = E(x)$ and $\tilde{z} = E(z)$. In other words, t^0 and c^{I0} solve (8). To compare the optimally chosen level of consumption in the deterministic case, c^{I0}, with that chosen under small uncertainty, expand (4.7-a) around $x = \tilde{x}$ and $z = \tilde{z}$. Neglecting terms of order higher than 2, and assuming that y^E and y^I are linear in x and z, respectively, this results in the following expression (derivation see Appendix 3):

$$E^0(u'^I(c^I) - u'^E(c^E)) \approx -\frac{1}{2}\frac{1}{[1-t]^2}u'''^E(c^E)\,[Var(y^E + y^I)] \qquad (4.11)$$

where $E^0(.) = E(.)$ when $z = \tilde{z}$ and $x = \tilde{x}$. It follows from the second order conditions that $\phi_{c^I c^I} < 0$ (see Appendix 1). Accordingly, $d\,E^0(u'^I(c^I) - u'^E(c^E))/dc^I < 0$. Therefore, the optimally chosen level of consumption in the host country under small uncertainty is smaller or larger than that chosen in the certainty case, depending on whether the term on the right hand side of (4.11) is negative or positive, respectively. Since $Var(y^E + y^I)$ will always be positive, the sign of the term on the right of (4.11) depends on the sign of $u'''^E(c^E)$, indicating the change in the attitude towards risk when c^E changes. When $u'''^E(c^E) = 0$, the optimal level of consumption is not affected by uncertainty. This is, for instance, the case for a quadratic utility function.

However, for $u'''^E(c^E) > 0$, it follows from (4.11) that $c^{I0} > \hat{c}^I$, where $\hat{c}^I$ is the optimal level of consumption when small uncertainty about income at home and abroad is present. It is easy to show that $u'''^E(c^E)$ has to be positive when absolute risk aversion is decreasing and the utility function is additively separable (see Leland (1968))[17] If the migrant's utility structure exhibits decreasing absolute risk aversion, he would, under small uncertainty, accumulate precautionary savings and increase the level of consumption in the home country even if he were indifferent between consumption at home and abroad. The interesting question that arises is whether precautionary savings of migrant workers differ from those of comparable natives.[18]

It is obvious from (4.11) that the impact of uncertainty on the savings decision depends on the size of $Var(y^E + y^I)$, the variance of lifetime income. $Var(y^E + y^I)$ may be rewritten as:

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[17]For an extensive discussion of the properties of the third derivative of the utility function and its impact on savings behavior, see also Mirman (1971) and Sandmo (1971).

[18]Since the analysis of precautionary savings requires at least a two-period framework, assume, as before, that the life of the comparable native is divided into two periods of unequal length, period 1 corresponding to t and period 2 to $(1-t)$. Comparisons of savings of migrant workers with those of natives refer then to the first period.

$$Var(y^E + y^I) = Var(y^E) + Var(y^I) + 2\,Cov(y^E + y^I) = [y_x^{I2}\sigma_x^2 + y_z^{E2}\sigma_z^2 + 2\rho y_x^I y_z^E \sigma_x \sigma_z] \tag{4.12}$$

Accordingly, the variance of the migrant's lifetime income consists of the variance of total incomes in the host- and in the source country, both depending positively on the time spent in either country, and on the covariance between both. The degree of risk exhibited by the respective labor market may be measured by σ_i^2, $i = z, x$. Assume first that the random variables x and z are uncorrelated.

The variance of lifetime income of a migrant worker, and, accordingly, his precautionary savings, may then be higher than that of a comparable native worker for two reasons: the variance of income to be accumulated in the host country is higher than that of the native worker, or/and the variance of income to be accumulated at home is higher than that of the native worker, both evaluated over the same period length t.

First consider $Var(y^I)$, the variance of total income to be accumulated abroad. Evaluated for the same t, $Var(y^I)$ is higher for migrant workers than for comparable natives if migrants perceive the host country labor market as more risky than native workers. It is likely that this is the usual case. For instance, in many immigration countries migrant workers do not have the same rights in the labor market or the same benefit entitlements than native workers. Furthermore, discrimination may prevent migrant workers from having the same opportunities to stay in the job, or to find a new job, especially during economic downturns. The variance of lifetime income for a migrant worker would then be higher than that of a native worker, given that the variance of income in the home country over the remaining period $[1 - t]$ is not lower than that of the respective native worker over that period.[19]

Secondly, higher precautionary savings of migrants may be induced by the desired, temporary nature of migration. If the migrant stays only temporarily in the host country, and, after return, enters the labor market of the home country, the variance of his lifetime income depends on the riskiness of the home country labor market. Emigration countries are often characterized by poorly developed benefit systems.[20]

[19]The variance of total income to be accumulated in the host country should be particularly high for illegal migrants. They usually do not have the right to claim any benefit support in the host country. Furthermore, their illegal status prevents them from appealing to any labor market law that concerns minimal wages or job security.

[20]Although institutionally established benefit systems are often less developed in potential emigration countries, it would be wrong to conclude that migrants are always better off in immigration countries. Less economically developed emigration countries have very often a well-functioning, non-

They usually exhibit fairly high rates of unemployment, low stability and are sometimes highly sensitive to economic shocks. Therefore, the variance of the migrant's income to be accumulated after return may be high, thus further increasing the variance of lifetime income, respective to that of a comparable native worker.

Furthermore, the correlation between the effects of some shocks on the labor market of emigration- and immigration country may well be positive or negative. In this case, not only the variances of y^E and y^I, but also the covariance between y^E and y^I determines the size of $Var(y^E + y^I)$. A positive correlation between total incomes to be accumulated at home and abroad would signify that the same type of event has either a positive or a negative effect on labor markets and earnings in both countries. A negative correlation would correspond to opposite effects on labor markets in the two countries.

Assume, for instance, that the emigration country is a net importer of some raw materials, e.g. crude oil, while the immigration country is a net exporter. A rise in oil prices would then have a positive effect on the economy of the immigration country and a negative effect on the economy of the emigration country. On the contrary, if both economies were net importers of crude oil, a rise or fall in oil prices would affect both economies similarly.

The correlation of the effect of such an event on labor markets and, accordingly, earnings is captured by the correlation coefficient ρ in (4.12). When $\rho = 0$, total incomes in the two countries are uncorrelated. Should $\rho < 0$, some shock would have opposite effects on the two economies. This allows the migrant to hedge against risk. For a negative correlation, there exists an optimal level of consumption and an optimal length of time abroad so that all risk would be removed from the migrant's decision problem. Accordingly, the correlation between the effects of some random shocks on the labor markets, mirroring characteristics and interdependencies of the economies considered, may weaken or reinforce the size of precautionary savings.

Consequently, when the utility structure of migrants exhibits decreasing absolute risk aversion, migrants are likely to accumulate precautionary savings that are higher than those of comparable natives. The size of savings that are due to precautionary motives depends on the perceived riskiness of the host country labor market and the home country labor market, determining the variance of total earnings in either country, and on the length of migration. It further depends on the correlation of the effects of some shock on labor markets in both countries.

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institutionalized benefit systems that is based on kinship and family. While the migrant worker may rely in his home country on family support in the case of unemployment or illness, he may end up with no benefits at all, if the host country benefit system discriminates against foreigners.

4.2.3 Uncertainty and Migration Decisions

Uncertainty does not only influence migrant's savings in the host country, as was shown above, but also his optimal length of stay abroad and, when analyzed around $t^0 = 0$, the migration decision itself. To investigate the effect of income uncertainty on the optimal choice of t, denote t^0 and c^{I0} as those realizations of t and c^I which solve the migrant's decision problem when x and z are known to be equal to their expected values. Expanding (4.7-a) around $x = \tilde{x}$ and $z = \tilde{z}$, and assuming that y^I and y^E are linear in x and z, respectively, results in the following expression (for the derivation see Appendix 3):

$$E^0[u^I(c^I) - u(c^E)] + E^0\left[u'^E(c^E)\left[\frac{dc^E}{dt}[1-t]\right]\right] \approx \Delta^1 + \Delta^2 = \Delta \qquad (4.13)$$

$$\Delta^1 = \frac{1}{2}\frac{1}{[1-t]^2}\left[u'''^E(c^E)\frac{dc^E}{dt} + u''^E(c^E)\right]\ [Var(y^E + y^I)]$$

$$\Delta^2 = \frac{1}{2}\frac{1}{[1-t]}u''^E(c^E)\left[\frac{d}{dt}Var(y^E + y^I)\right]$$

where E^0 again indicates that the expectations are evaluated at $x = \tilde{x}$ and $z = \tilde{z}$. For $\phi_{tt} < 0$ (see Appendix 1), the term on the left decreases in t. As a result, the optimally chosen level of t under small uncertainty, $\hat{t}$, is smaller or larger than that chosen in the deterministic case, t^0, depending on whether Δ is smaller or larger than zero:

$$\hat{t} \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} t^0 \quad \text{if} \quad \Delta \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} 0$$

Uncertainty affects the optimal choice of t directly and indirectly. Directly because the migrant is risk averse. Indirectly because a change in t changes the variance of total lifetime earnings, and, by way of altering c^E, changes the attitude towards risk. The direct effect of risk aversion and the indirect effect via a change in the degree of risk aversion are captured by Δ^1. The indirect effect via a change in the variance of total lifetime income is captured by Δ^2.

Consider first Δ^1: since $Var(y^I + y^E) > 0$, the sign of Δ^1 depends on the sign of $u'''^E(c^E)$. It further depends on the magnitudes of $u'''^E(c^E)\,[dc^E/dt]$ and $u''^E(c^E)$. For a given variance of total lifetime income, $u''^E(c^E)$ captures the direct effect of uncertainty

Table 4.1: $\frac{1}{2}\frac{d}{dt}Var(y^I + y^E)$

Corr	$0 < t^0 < 1$	$t^0 = 0$
$\rho = -1$	$\underbrace{\underbrace{[y_x^H\,\sigma_x - y_z^E\,\sigma_z]}_{>\text{or}<0}\ \underbrace{[y_{xt}^I\,\sigma_x - y_{zt}^E\,\sigma_z]}_{>0}}_{>\text{or}<0}$	$\underbrace{\sigma_z\, y_z^E[y_{zt}^E\,\sigma_z - y_{xt}^I\,\sigma_x]}_{<0}$
$\rho = 0$	$\underbrace{\underbrace{[y_x^I\, y_{xt}^I\,\sigma_x^2}_{>0} + \underbrace{y_z^E\, y_{zt}^E\,\sigma_z^2]}_{<0}}_{>\text{or}<0}$	$\underbrace{y_z^E\, y_{zt}^E\,\sigma_z^2}_{<0}$
$\rho = 1$	$\underbrace{\underbrace{[y_x^I\,\sigma_x + y_z^E\,\sigma_z]}_{>0} + \underbrace{[y_{xt}^I\,\sigma_x + y_{xt}^E\,\sigma_z]}_{>\text{or}<0}}_{>\text{or}<0}$	$\underbrace{\sigma_z\, y_z^E[y_{xt}^I\,\sigma_x + y_{zt}^E\,\sigma_z]}_{>\text{or}<0}$

on the choice of t. The term $u'''^E(c^E)[dc^E/dt]$ represents the indirect effect by a change in the attitude towards risk, caused by a change in desired consumption at home, c^E, that results from a change in t.

Given the structure of the problem, decreasing absolute risk aversion would imply that $u'''^E(c^E) > 0$. Accordingly, for $dc^E/dt = [y_t^I + y_t^E - c^I + c^E] > 0$, an increase in t would, by way of increasing the flow of consumption in the home country, increase the willingness to accept some given risk and influence the length of migration positively. However, since the direct effect is negative ($u''^E(c^E) < 0$), the sign of Δ^1 is ambiguous.

The second indirect effect is induced by the impact of a change in t on the variance of total lifetime income. This effect is captured by the term Δ^2. Since $u''^E(c^E) < 0$, the sign of Δ^2 depends on the sign on $dVar(y^E + y^I)/dt$. When, for some t^0, $dVar(y^E + y^I)/dt < 0$, an increase of the time being in the host country will reduce the variance of total lifetime income. This would be the case when, for instance, the labor market of the home country is very risky, relative to that of the host country.

Consequently, risk aversion would then induce the migrant to increase the length of stay abroad. This can directly be seen from (4.13): For $dVar(y^E + y^I)/dt < 0$, and $u''^E(c^E) < 0$, $\Delta^2 > 0$. Accordingly, should $\Delta^1 > 0$, or $(\Delta^1 + \Delta^2) > 0$, it follows that $\hat{t} > t^0$.

The sign of $dVar(y^E + y^I)/dt$ depends on the degree of risk in the respective labor markets, as represented by σ_x and σ_z, and on the correlation between the random variables x and z. For $\rho = -1$, $\rho = 0$ and $\rho = 1$, the first column in table 4.1 presents

$[1/2]\, dVar(y^E+y^I)/dt$ when the solution of the deterministic problem is an interior one $(0 < t^0 < 1)$. The second column of table 4.1 gives $dVar(y^E+y^I)/dt$ when the solution of the deterministic problem would be $t^0 = 0$ (i.e. the objective function reaches it's maximum for $t^0 = 0$). Without further specification of y^I, y^E and the distribution of x and z as well as the migrant's utility function and the income functions in both countries, it is ambiguous whether Δ^2 will tend to have an increasing or a decreasing effect on the time spent abroad, compared with what would have been chosen under certainty. In other words, depending on the migration situation and the preference structure of the migrant worker, uncertainty may have a positive or a negative effect on the time the migrant intends to stay abroad.

The effect of Δ^2 is more definite when the migration decision itself is considered. Neglecting the effect of Δ^1, column 2 of table 4.1 shows that uncertainty with respect to future income would induce the migrant to migrate, even if he would not do so under perfect foresight, when x and z are negatively correlated or not correlated. This is due to the purpose of the migrant to hedge against risk or to diversify risk, respectively. However, when x and z are positively correlated, the effect of Δ^2 on the migration decision is again ambiguous.

An Example

A simple numerical example may help to illustrate the above arguments. Assume the migrant's utility structure to be of the following simple form:

$$u(c^I) = G\, c^{I\,0.5}; \qquad u(c^E) = F\, c^{E\,0.5}$$

where F and G are indices which capture environmental arguments, like family, friends etc. The utility function has the property that $u''' > 0$. Let $F > G$, and normalize by setting $G = 1$.

Assume that total earnings in host- and home country, y^I and y^E, are linear in x and z, as well as in t and $[1 - t]$:

$$y^I = w^I\, t\, x; \qquad y^E = w^E\, [1 - t]\, z$$

Again, w^I and w^E denote earnings per unit of time in immigration- and emigration country.

Assume some numerical values. Suppose that $w^E = 1$, $w^I = 2$ and $F = 2$. Acordingly, wages in the host country are double as high as in the home country. Further, let the price level between host- and home country be equal ($p = 1$), and set the fixed costs of migration to zero ($\eta = 0$).

When the random variables x and z are known to be equal to their expected values, and expectations are equal to unity ($E(x) = E(z) = 1$), the optimal flows of consumption at home and abroad and the optimal length of migration are given by the following numbers:

$$c^I = \frac{1}{3}; \quad c^E = \frac{4}{3}; \quad t = \frac{1}{6}$$

Consequently, the migrant would intend to spent 1/6 of his future life abroad. His consumption per unit of time abroad would only be 1/4 of what he plans to consume in his home country. His total savings rate s^M, consisting of s_1^M and s_2^M, is given by:

$$s^M = s_1^M + s_2^M = 0.416 + 0.416 = 0.83$$

In this simple example, the migrant would intend to save 83% of his wage income.

Consider now the case of uncertainty. Let the random variables x and z have means of unity, variances σ_x^2 and σ_z^2 and covariance $\sigma_x \sigma_z \rho$.

Three situations will be examined. In situation 1, the migrant perceives the labor market of the home country as riskier than that of the host country. In situation 2, the opposite is the case: the migrant considers the host country labor market as riskier than that of the home country.[21] In situation 3, the host country labor market is likewise riskier than that of the home country, but the difference in the degree of risk is smaller. The following values will be assumed:

- Situation 1: $\sigma_x = 0.5$; $\sigma_z = 0.8$
- Situation 2: $\sigma_x = 0.9$; $\sigma_z = 0.3$
- Situation 3: $\sigma_x = 0.8$; $\sigma_z = 0.5$

[21] Note that the labor market of the host country may exhibit a different degree of risk for the migrant than for the native worker. The degree of risk depends on the extent to which the foreign labor market is discriminative against migrant workers, the migrant's legal rights to claim benefit support in the case of unemployment, illness etc.

Table 4.2: Some Qualitative Results

Corr	$dVar(y^I + y^E)/dt$			Δ^1			Δ^2			$\Delta^1 + \Delta^2$		
Situation	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\rho = 1$	(+)	(+)	(+)	(+)	(+)	(+)	(-)	(-)	(-)	(+)	(-)	(-)
$\rho = 0$	(-)	(+)	(+)	(+)	(+)	(+)	(+)	(-)	(-)	(+)	(-)	(+)
$\rho = -1$	(-)	(+)	(-)	(+)	(+)	(+)	(+)	(-)	(+)	(+)	(-)	(+)

In all situations, the migrant will accumulate precautionary savings, since $u'''(.) > 0$. For the assumed utility structure, the effect of uncertainty on the desired length of migration depends on the riskiness of the two labor markets, as well as on the correlation between the effects of some event on them. Table 4.2 presents qualitative results for $dVar(y^I + y^E)/dt$, Δ^1, Δ^2, and $\Delta^1 + \Delta^2$.

In situation 1, a further stay abroad would increase the variance of lifetime income for $\rho = 1$. It would decrease the variance of lifetime income for $\rho = 0$ and $\rho = -1$. In situation 2, an increase in the t increases the variance of lifetime income for all ρ's. In situation 2, the variance rises likewise, except for $\rho = -1$. The direct effect of risk aversion and the effect of a change in the degree of risk aversion on the optimal length of migration, as represented by Δ^1, is positive in all situations and for all ρ's. It therefore affects the desired time abroad positively. However, Δ^2, which captures the effect of a change in the total variance of lifetime income on the optimal t, is negative in situation 1 for $\rho = 1$. It is negative for all correlations in situation 2. In situation 3, it is again negative for $\rho = 1$ and $\rho = 0$, but positive for $\rho = -1$. Summing up Δ^1 and Δ^2, the total effect of uncertainty in situation 1 would be to increase the length of the migration period, compared to what would have been chosen under certainty. In situation 2, uncertainty has a decreasing effect on the desired length of stay abroad. Finally, in situation 3, the effect is negative for $\rho = 1$ and positive for $\rho = 0$ and $\rho = -1$.

This exercise should have demonstrated the main result of the analysis in section 4.2.3: income uncertainty affects the migrant's desired length of stay and, in the limit, the migration decision itself. However, the effect is not conclusive without specifying the migrant's optimization problem explicitly. Depending on the migrant's preference structure, the specification of the income functions and the distribution of and correlation between the random variables x and z, uncertainty may increase or reduce the

desired time in the host country, relative to that chosen under certainty.

4.2.4 *Type 2* Uncertainty

So far, only the impact of *type 1* uncertainty has been analyzed. Additionally to *type 1* uncertainty, *type 2* uncertainty may influence the migrant's decision problem.

With *type 2* uncertainty, the potential migrant is before migration uncertain about how the foreign labor market evaluates his abilities and his stock of human capital. However, once arrived in the foreign country, he will gather information about the requirements of the labor market and thereby reduce uncertainty.

Uncertainty that is due to imperfect information is likely to play a minor role when there is an established and long-lasting migration relation between target- and source country. Returners may have thoroughly informed new potential migrants about the immigration country.[22] However, for the first wave of migrants, *type 2* uncertainty may play a major role in the decision process. Which kind of uncertainty finally dominates, depends on the migration situation under consideration. Although both types of uncertainty are likely to affect the migrant's optimization problem simultaneously, the effect of *type 2* uncertainty on the decision variables will be analyzed separately.

Since *type 2* uncertainty only affects earnings abroad, assume earnings at home as certain. Define ξ as the random variable that reflects uncertainty which is due to imperfect knowledge about the foreign labor market. Let $g(\xi)$ be the known density function of ξ, with variance σ_ξ. Future income abroad is then given by $y^I(t,\xi)$. Given that the stock of knowledge about the foreign economy rises while the migrant stays abroad, an increase in t should reduce uncertainty that is due to imperfect knowledge. It therefore seems to be reasonable to adopt the assumption of *decreasing risk*: $y^I_{t\xi} < 0$.

Consider first precautionary savings: the variance of total lifetime income, $Var(y^E + y^I)$, reduces to $y^{I\,2}_\xi \sigma^2_\xi$, which is always positive. Accordingly, uncertainty that is due to imperfect knowledge would likewise induce the migrant to accumulate precautionary savings.

To analyze the effect of *type 2* uncertainty on the length of migration, one has to evaluate Δ^1 and Δ^2. The sign of Δ^1 is again ambiguous. The sign of Δ^2 depends on $dVar(y^E + y^I)/dt$, which reduces to $dVar(y^I)/dt = y^I_\xi \sigma_\xi y^I_{\xi t}$. This term is always negative since y^I_ξ decreases in t. Accordingly, and neglecting the effect of Δ^1, the effect of Δ^2 alone would then always be to increase the time to be spent in the host

[22] An example would be migration of turkish workers to Germany during the early seventies, after the two countries have had an established migration history of nearly two decades.

country. This is a direct result of *decreasing risk* when uncertainty is due to imperfect information.

4.3 Conclusion

The aim of the above analysis was twofold: First, to analyze the motives that may be responsible for the surprisingly high saving rates of migrant workers. Secondly, to investigate the impact of uncertainty with respect to future incomes on the migration decision and the length of time the migrant intends to stay abroad.

The analysis isolates two motives which may explain to some extent why temporary migrants often have savings that are considerably higher than those of comparable native workers: life cycle motives and precautionary motives. Savings that are due to life cycle motives are likely to be higher for migrants than for native workers. The difference between saving rates is the greater, the larger the wage differential between home- and host country, the stronger the migrant's preference for consumption at home and the higher the relative price level in the immigration country. It decreases with the length of migration.

The migrant may further accumulate precautionary savings. For uncertain future income flows in home- and host country, the magnitude of precautionary savings depends on the size of the variance of future income. It is shown that this variance is likely to be larger for migrants than for native workers. In particular, precautionary savings are likely to be higher for migrants when foreigners can not claim the same rights in the labor market of the immigration country than native workers, when the labor market of the host country discriminates against foreign workers, when the migrant has an illegal status, and when the labor market of the home country exhibits a high degree of risk and instability, leading to a high variance of income to be accumulated after return. These effects are reinforced by a positive correlation between the impact of some random shocks on the labor markets considered, and weakened by a negative correlation.

The effect of uncertain future income on the migration decision and the length of the migration period is inconclusive. It depends on the specification of the utility structure and the income structure of the migrant. It further depends on the perceived degree of risk exhibited by both labor markets and the correlation between the impact of random shocks on labor markets in both countries considered.

Uncertainty affects both the decision to migrate as well as the desired length of stay. The analysis shows that this effect is generally ambiguous, not only in size, but also in sign. Accordingly, conclusions for one migration situation, and for one type of migrant may be inappropriate when another migration situation and another type of migrant worker are considered.

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4.4 Appendix

Appendix 1: The Sufficiency Conditions

Let $\psi(c^I, t, x, z) = t\,u^I(c^I) + [1-t]\,u^E(c^E)$ for any x, z defined over the range $(\underline{x}, \bar{x})$ and $(\underline{z}, \bar{z})$, where $\underline{x}$, $\underline{z}$ and $\bar{x}$, $\bar{z}$ are the lower and upper limits of the distributions of x and z, respectively. Then it follows for $\psi_{c^I c^I}$:

$$\psi_{c^I c^I} = t\,u''^I(c^I) + \frac{t^2}{[1-t]}\,p^2\,u''^E(c^E) \tag{4.14}$$

and for ψ_{tt}

$$\psi_{tt} = [1-t]\,u''^E(c^E)\left[\frac{dc^E}{dt}\right]^2 - u'^E(c^E)\frac{dc^E}{dt} + u'^E(c^E)\,[y^I_{tt} + y^E_{tt}] \tag{4.15}$$

$\psi_{c^I c^I}$ is definitely negative. ψ_{tt} is smaller than zero for y^I and y^E being concave in t. However, when y^I and y^E are convex in t, as it would be the case when human capital accumulation is allowed for (see Appendix 2), then $\psi_{tt} < 0$ iff $|[1-t]u''^E(c^E)[dc^E/dt]^2 - u'^E(c^E)[dc^E/dt]| > |u'(c^E)[y^I_{tt} + y^E_{tt}]|$. That this is the case will be assumed throughout the analysis. Furthermore, $\psi_{tc^I} = -p\,t\,u''^E(c^E)[dc^E/dt]$. It follows that $\psi_{c^I c^I}\,\psi_{tt} > \psi^2_{tc^I}$. Since ψ is concave in c^I, t for all x, z, the same must be true for $\phi = E(V(c^E, c^I))$.

Appendix 2: Changes in the Stock of Human Capital

The functions of total income abroad and at home, y^I and y^E, may well be nonlinear in t. To see this, consider the deterministic case and denote by $\bar{y}^I(t)$ and $\bar{y}^E(t)$ total earnings accumulated at home and abroad, respectively. Let v^I be the rental rate on one *unit* of human capital stock abroad and v^E be the rental rate on one *unit* at home. Assume the accumulation of human capital as exogenous and as independent of whether the migrant stays abroad or at home. Denote the stock of human capital in t by $h(t)$, with $h'(t) > 0, h''(t) < 0$. The strict concavity of the human capital stock is in line with human capital theory and compatible with empirical evidence [see chapters 2 and 3]. Denoting t as the point of re-migration, total lifetime earnings are then given by $\bar{w}$:

$$\bar{w}(t) = \bar{y}^I(t) + \bar{y}^E(t) = \int_0^t v^I\,h(\tau)\,d\tau + \int_t^1 v^E\,h(\tau)\,d\tau \tag{4.16}$$

Specify, for instance, $h(t)$ as $[h(t) = \gamma + t^{0.5}]$. Inserting in (4.16) and solving yields:

$$\bar{w}(t) = [v^I - v^E]\left[\gamma\,t + \frac{1}{1.5}\,t^{1.5}\right] + v^E\left[\gamma + \frac{1}{1.5}\right] \tag{4.17}$$

Each additional unit of time spent abroad increases lifetime earnings by $\bar{w}_t = \bar{y}^I_t + \bar{y}^E_t$:

$$\bar{w}_t = [v^I - v^E][\gamma + t^{0.5}] \tag{4.18}$$

Equation (4.18) is positive for $v^I > v^E$. The profile of $\bar{w}$ is then a strictly convex function of t:

$$\bar{w}_{tt} = 0.5[v^I - v^E]t^{-0.5} > 0 \tag{4.19}$$

An interesting case to consider is now the following: the migrant accumulates human capital while being abroad. In the host country, he does not receive a higher pay for this additional human capital. It increases, however, his potential earnings in the home country. In other words, the additionally acquired human capital is only earnings effective back home.

Such a situation could occur if the migrant has no occupational choice in the host country, or he may by purpose accumulate human capital that is only of use later in the home country. In such a situation, migration may be temporary, although the migrant is indifferent between consumption at home and abroad and although initially wages are higher abroad.

To see this, assume the extreme case: let the migrant accumulate human capital abroad, but only get paid for this additional stock of human capital back home. For the above specification of the human capital function, lifetime income is then:

$$\bar{w}(t) = \int_0^t \gamma\, v^I\, d\tau \quad + \int_t^1 v^E\,[\gamma + \tau^{0.5}]\, d\tau \tag{4.20}$$

and

$$\bar{w}_t = \bar{y}_t^I + \bar{y}_t^E = \gamma\,[v^I - v^E] - v^E\, t^{0.5} \tag{4.21}$$

For this specific example, migration would be temporary if there exists a $t \in [0,1]$ that solves $\bar{w}_t = 0$, i.e. when $\{\gamma\,[v^I - v^E]/v^E\}^2 = t^*$ and $0 < t^* < 1$.

Appendix 3: Derivation of equations 11 and 13.

A second order expansion of (4.8-a) around $x = E(x) = \tilde{x}$ and $z = E(z) = \tilde{z}$, and neglecting higher order terms, yields:

$$E[u'^H(c^H) - (u'^E(c^E))] \approx u'^I(c^I) - u'^E(c^{E0}) - \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} \left\{ \frac{\delta}{\delta x} u'^E(c^E)[x - \tilde{x}] \right.$$
$$+ \frac{\delta}{\delta z} u'^E(c^E)[z - \tilde{z}] + \frac{1}{2}\frac{\delta^2}{\delta x^2} u'^E(c^E)[x - \tilde{x}]^2 + \frac{1}{2}\frac{\delta^2}{\delta z^2} u'^E(c^E)[z - \tilde{z}]^2$$
$$\left. + \frac{\delta}{\delta x\, \delta z} u'^E(c^E)[x - \tilde{x}][z - \tilde{z}] \right\} f(x,z)\, dx\, dz \tag{4.22}$$

where all derivatives are evaluated at $x = \tilde{x}$ and $z = \tilde{z}$. When assuming that y^I and y^E are linear in x and z, respectively, (4.22) simplifies to:

$$E^0\left[u'^I(c^I) - u'^E(c^E)\right] \approx u'^I(c^{I0}) - u'^E(c^{E0}) - \frac{1}{2}\frac{1}{[1-t]^2}u'''(c)\left[y_x^{I2}\sigma_x^2 + y_z^{E2}\sigma_z^2 + 2\rho\, y_x^I y_z^E \sigma_x\sigma_z\right] \tag{4.23}$$

Expanding $Var(y^I + y^E)$ around the mean values of x and z yields (for linear risk):

$$Var(y^I+y^E) = Var(y^I)+Var(y^E)+2\,Cov(y^I,y^E) \approx \left[y_x^I\sigma_x^2 + y_z^{E2}\sigma_z^2 + 2\rho\, y_x^I y_z^E \sigma_x\sigma_z\right] \tag{4.24}$$

Substituting into (4.23):

$$E^0(u'^I(c^I) - u'^E(c^E)) \approx u'^I(c^{I0}) - u'^E(c^{E0}) - \frac{1}{2}\frac{1}{[1-t]^2}u'''^E(c^E)\left[Var(y^E + y^I)\right] \tag{4.25}$$

Since the first order condition of the deterministic problem requires that $u'^I(c^{I0}) - u'^E(c^{E0}) = 0$, (4.11) follows directly from (4.25).

The derivation of (4.12) follows the same lines:

$$E^0[u^I(c^I) - u^E(c^E)] + E^0\left[u'^E(c^E)\frac{dc^E}{dt}[1-t]\right] \approx u^I(c^{I0}) - u^E(c^{I0}) +$$

$$u'^E(c^{E0})\left[\frac{dc^E}{dt}\right]^0[1-t] + \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\left\{\frac{\delta}{\delta x}\left[u'^E(c^E)\frac{dc^E}{dt}[1-t] - u^E(c^E)\right][x-\tilde{x}]\right.$$

$$+\frac{\delta}{\delta z}\left[u'^E(c^E)\frac{dc^E}{dt}[1-t] - u^E(c^E)\right][z-\tilde{z}] + \frac{1}{2}\frac{\delta^2}{\delta x^2}\left[u'^E(c^E)\frac{dc^E}{dt}[1-t]\right.$$

$$\left.-u^E(c^)\right][x-\tilde{x}]^2 + \frac{1}{2}\frac{\delta^2}{\delta z^2}\left[u'^E(c^E)\frac{dc^E}{dt}[1-t] - u^E(c^E)\right][z-\tilde{z}]^2$$

$$\left.+\frac{\delta}{\delta x\,\delta z}\left[u'^E(c^E)\frac{dc^E}{dt}[1-t] - u^E(c^E)\right][x-\tilde{x}][z-\tilde{z}]\right\} f(x,z)\,dx\,dz \tag{4.26}$$

where $c^E = \frac{1}{1-t}[y^I + y^E - t\,c^I - \eta]$ and $\frac{dc^E}{dt} = \frac{1}{1-t}[y_t^I + y_t^E - c^I + c^E]$

After some tedious calculations, (4.26) simplifies to:

$$E^0[u^I(c^I) - u^E(c^E)] + E^0\left[u'^E(c^E)\frac{dc^E}{dt}[1-t]\right] \approx u^I(c^{I0}) - u^E(c^{E0}) +$$

$$u'^E(c^{E0})\left[\frac{dc^E}{dt}\right]^0[1-t] + \frac{1}{2}\frac{1}{[1-t]^2}\left[u'''^E(c^E)\frac{dc^E}{dt} + u''^E(c^E)\right]\left[y_x^{I2}\sigma_x^2 + y_z^{E2}\sigma_z^2 + 2y_x^I y_z \sigma_{xz}\right]$$

$$+\frac{1}{[1-t]}u''(c)[y_x^I y_{xt}^I\sigma_x^2 + y_z^E y_{zt}^E\sigma_z^2 + [y_{xt}^I y_z^E + y_{zt}^E y_x^I]\sigma_{xz}] \tag{4.27}$$

It follows from (4.24):

$$\frac{d}{dt} Var(y^E + y^I) = 2\left[y_x^I y_{xt}^I \sigma_x^2 + y_z^E y_{zt}^E \sigma_z^2 + [y_{xt}^I y_z^E + y_{zt}^E y_x^I]\sigma_{xz}\right] \tag{4.28}$$

Again, it follows from the first order conditions of the deterministic problem that $u^I(c^{I0}) + u^E(c^{E0}) + u'^E(c^{E0})\left[\frac{dc^E}{dt}\right]^0 [1-t] = 0$. Consequently, substituting (4.28) into (4.27) yields (4.13).

Chapter 5

Do We Stay or Not? Return Decisions of Temporary Migrants.

5.1 Introduction

Return migration[1] was, and is a widely observed phenomenon. This is true not only in Europe and between European and extra-European countries, but also in Asia as well as between Asian countries and countries of the Middle East. Migration decisions of return migrants are induced mainly by economic motives. Return migrants do not initially have a strong desire to live in the target country for other than economic reasons.

The target countries of return migration are generally characterized by an excess demand for labor in at least some segments of the labor market. This labor can not be supplied by the local workforce either in the quantity requested, or at adequate prices, or both. The emigration countries usually exhibit an excess supply of labor and/or wage rates that are far below those offered in the target countries.[2]

Economic theory has little to say about return migrants. There are a number of open questions. First of all, why do return migrants initially intend to return? And

[1]The term *return migration* will here be used to characterize a situation where migrant workers return, or, at least, initially intend to return to their country of origin after a significant period abroad.

[2]In the 50's, 60's and 70's, the labor requirements of Western Europe's industrial economies and poverty as well as unemployment in Southern European countries and in Turkey induced an immigration boom from the periphery countries into the core of Europe. At present, a similar situation can be found between Asian countries, like Thailand, and the Gulf states. It is likely that return migration will start in the near future between Europe's Eastern countries and industrialized Western economies.

why, after living for some time in the host country, some do return, and others would like to stay permanently? Are there measurable characteristics that help to distinguish between those who want to return, and those who want to stay? And why do some migrants stay longer than others?

Answers to these questions may help policy makers to control return migration and to target eventual incentive programs more efficiently. Migration policy could be designed to influence the migrant's decisions so as to correspond deliberately to the targets of policy makers. The understanding of the migrant's decision process is an important presupposition for the construction of effective migration policies.

This paper will try to give answers to some of the questions raised above. Section 5.2 develops a theoretical model of return migration. The model implies that the time a migrant worker intends to further remain in the host country (and, in the limit, the decision whether or not to return at all) depends essentially on 4 factors: the earnings situation in the host country relative to that in the home country, the perception of *environmental factors* (social relations, climate etc.) abroad relative to that at home, the remaining lifetime horizon, and the stock of savings accumulated so far. In section 5.3, the qualitative implications of the theory are empirically tested, using micro data on temporary migrants to Germany. The data set contains information about the intention of the migrant whether to stay permanently in Germany or not. For those who do not wish to stay permanently it includes information about the number of years migrants want to stay before returning home. The empirical analysis follows two steps: first, logit models are estimated, differentiating between the subsample of those who want to return and those who want to stay permanently. Secondly, and restricting the analysis to those migrants who want to return, a duration analysis is performed on the migrant's intended further duration in the host country.

The study provides some insight into the dependence of migrants return probabilities and intended spells of further duration on measurable characteristics.

5.2 Theory

The classical argument to explain migration is the following: neglecting any fixed costs of migration, a worker has an incentive to migrate when, given his stock of human capital, his potential earnings are higher in the host- than in the home country. Therefore, if earnings differentials were the only determinant for migration decisions, migrants would only return when the economic situation changes so that earnings at

home will significantly increase relative to those of the host country.[3] However, since return migration is a phenomenon that can be observed even without such changes of economic situations in the countries concerned, migrants are obviously not only maximizers of lifetime income. Without exogenous restrictions on their choice set, such behavior indicates that migrants are not simply maximizers of lifetime income. They rather maximize a utility function that contains some arguments that may explain the temporary nature of migration.

It is a common observation that utility created by the consumption of goods depends not only on the quantities consumed, but also on the *environment* where such consumption takes place. More specifically, it seems to be the case that the environment where consumption comes about is complementary to the utility created by the consumption good itself. The notion environment as it will be used here could comprise social relations, subjectively perceived life quality parameters, like climate, social regulations etc., family and friends. When analyzing agents' consumption behavior in a relatively stable environment, any interactions between environment and the utility gained by the consumption of some good may be neglected. However, when analyzing agents who may, involuntarily or by choice, meet their decisions over their life cycle in two completely different environments, such interactions should be considered. This would be especially the case when investigating migrants who may return to their home countries.[4] The purpose of this section is to model their migration and re-migration decisions.

To formalize the notion *environment*, define an index N that summarizes all parameters that determine this environment. Let N be a further argument in the individual's utility function. N is assumed to be complementary to consumption.[5] Turning to the situation of the migrant worker, let $N = G$ when the migrant resides

[3]When real wages are higher in the host country, but prices are lower in the home country, a temporary migration may be optimal even when the migrant is a maximizer of lifetime income. Such considerations, however, are likely to play a minor part in the decision to return and are not further considered here.

[4]An important point seems to be worth emphasizing in this context: the difference between permanent migrants (migrants who migrate with the firm intention to stay permanently) and return migrants who initially intend to return but eventually stay forever. The economic behavior of both groups in the host country is likely to be very different. A return migrant who in the end stays permanently may have had over a long period of his stay in the host country the intention to return. As long as he wants to return, his economic decisions are sensitive to this intention, and it is irrelevant whether he finally stays permanently.

[5]Complementarity is here defined in the sense of Edgeworth and Pareto: *Y is complementary to X in the consumers budget if an increase in the supply of X (Y constant) raises the marginal utility of Y* (Hicks (1978), p.42).

in the home country and $N = F$ when he stays abroad. The migrant's migration- or re-migration decision is now based on the wage differential between home- and host country as well as on these environment indices.

Whenever $G > F$ (the environment index is higher in the home- than in the host country), and wages are higher abroad, the migrant worker may decide to migrate only temporarily. Both, F and G may, and probably will, change over the migrant's migration history. The longer the migrant stays abroad, the more he integrates into the new society, finds friends etc., and the less he feels attached to his home country environment. This process of social integration or disintegration is likely to affect strongly the size of the environment variables F and G, and is usually not perfectly foreseeable for the migrant worker. The migrant may therefore determine an optimal time to stay abroad at the beginning of his migration history, basing his decision on how he perceives F and G at that moment, or he may as well determine an expected path of F and G, $E\{F(t)\}_{t^0}^{T}$ and $E\{G(t)\}_{t^0}^{T}$, where T is the horizon to be considered and t^0 the point of decision making. Should now F and G change over the migration history in a way not previously foreseen by the migrant worker, he will reoptimize and redefine the time he further intends to stay abroad. Eventually, a previously intended temporary migration may become permanent - and this is an often observed phenomenon.

To clarify these ideas, a formal dynamic model in continuous time will be set up, describing the migrant's optimization problem. After some simplifications, an explicit solution for the time the migrant considers as optimal to still remain in the host country will be presented. The theoretical model implies qualitative predictions of the impact of explanatory variables on the migrant's decisions. It therefore provides the theoretical framework for the empirical analysis in section 5.3.

5.2.1 A Formal Model

Consider a migrant worker who decides at some point of his migration history how long he further wants to remain in the host country.[6] Assume that he has the following simple utility structure:

$$U = \begin{cases} U^I = U^I(c^I(t), F(t)) & : \quad t < \hat{t} \\ U^E = U^E(c^E(t), G(t)) & : \quad t \geq \hat{t} \end{cases} \tag{5.1}$$

with $U_1^i > 0$, $U_2^i > 0$, $U_{11}^i < 0$, $U_{22}^i < 0$, $U_{12}^i > 0$, $i = I, E$, where I signifies the immigration (host) country and E the emigration (source) country. The subscripts $1, 2$

[6]The migrant will solve the same problem when he has to decide whether or not to migrate.

indicate derivatives with respect to the first or second argument, respectively. The flow of consumption in country i is denoted by c^i, and F and G are the respective indices for environment as described above. $\hat{t}$ is the optimal time of return. Note that $\hat{t}$ is endogenous. F and G may change over time, but they are assumed to be independent of the migrant's decisions.[7]

To get some analytical results, assume that U is a Cobb-Douglas utility function. The migrant's lifetime utility function is then of the following form:

$$V = \int_{t^0}^{T} [c^I(t)^\alpha F(t)^{\alpha-1} e^{-\rho t}]\lambda(t) + [c^E(t)^\alpha G(t)^{\alpha-1} e^{-\rho t}][1 - \lambda(t)]\, dt \qquad (5.2)$$

where ρ is the rate of time preference and $[T - t^0]$ is the horizon considered. $\lambda(t)$ is a switching variable that takes the value 1 or 0, with $\lambda(t) = 1$ for $t < \hat{t}$ and $\lambda(t) = 0$ for $t \geq \hat{t}$. The intertemporal budget constraint is given by:

$$\dot{K}(t) = \lambda(t)\,[y^I(t) - c^I(t)] + [1 - \lambda(t)]\,[y^E(t) - c^E(t)] + r\,K(t) \qquad (5.3)$$

where $y^i(t)$ are earnings per unit of time, evaluated at t, in country $i = I, E$, and r is the rate of interest. $K(t)$ is the migrant's wealth at t. Accordingly, $\dot{K}(t)$ are savings at t. The migrant's optimization problem consists of the maximization of (5.2) subject to (5.3), where he chooses the path of c^i, $i = E, I$, and the path of $\lambda(t)$. He thereby determines the point of return. When the optimal path for λ is $\lambda(t) = 1\,\forall t$, $t \in [t^0, T]$, then the migrant will not return to his home country. Likewise, should it be optimal to set $\lambda(t) = 0\,\forall t$, $t \in [t^0, T]$, then the migrant will return immediately.[8] In what follows, the interior solution will be considered: it will be assumed that there exists a switching point of λ over the interval $[t^0, T]$.

The problem is a dynamic optimization problem. Setting up the Hamiltonian H, application of the maximum principle gives the necessary conditions for $\hat{c}^I(t), \hat{c}^E(t), \hat{K}(t), \hat{\lambda}(t)$ being an optimal solution to the problem (together with (5.3)):

$$\frac{dH}{dc^I} \;:\; \pi(t) = [\alpha\, c^I(t)^{\alpha-1}\, F(t)^{1-\alpha}]\, e^{-\rho t} \qquad (5.4\text{-a})$$

[7]This is, of course, not necessarily the case. The migrant may consciously influence (and, therefore, control) the adoption to his environment, e.g. by investment into country specific human capital (see Chapter 3). At least F would then be partly endogenous.

[8]When considering this decision problem before the migrant has migrated, the latter case would signify that no migration were the optimal policy, while in the former case the migrant would intend to migrate permanently.

$$\frac{dH}{dc^E} \; : \; \pi(t) = [\alpha\, c^E(t)^{\alpha-1}\, G(t)^{1-\alpha}]\, e^{-\rho t} \tag{5.4-b}$$

$$\frac{dH}{d\lambda} \; : \; \pi(t)\,[y^I(t) - y^E(t) + c^E(t) - c^I(t)] + [U(c^I(t), F(t)) - U(c^E(t), G(t))]\, e^{-\rho t} \; = \; 0 \tag{5.4-c}$$

$$-\frac{dH}{dK} \; : \; \dot{\pi}(t) = -\pi(t)\, r \tag{5.4-d}$$

$$[K(T) - \bar{K}]\, \pi(T) = 0 \tag{5.4-e}$$

The Hamiltonian is given by:

$$H = [\lambda(t)\, U^I(c^I(t), F(t)) + [1 - \lambda(t)]\, U^E(c^E(t), G(t))]\, e^{-\rho t} + \pi(t)\, \dot{K}(t) \tag{5.4-f}$$

The costate of the system, indicating the inner value of a change in the stock of savings, is denoted by $\pi(t)$. (5.4-e) is the transversality condition, where $\bar{K}$ denotes the desired stock of savings at the end of the planing horizon. Note that, since $\lambda(t) \in \{0, 1\}$, the paths of c^I, c^E and λ have a discontinuity at $t = \hat{t}$. Note further that (5.4-c) is only defined for $t = \hat{t}$. It follows from (5.4-d):

$$\pi(t) = \pi(T)\, e^{r(t-T)} = \bar{\pi}\, e^{r(t-T)} \tag{5.5}$$

The optimal paths of consumption abroad and at home are then given by:

$$c(t)^I = F(t) \left[\frac{1}{\alpha}\, \bar{\pi}\, e^{r(t-T)+\rho t}\right]^{\left[\frac{1}{\alpha-1}\right]} \quad \text{for } t < \hat{t} \tag{5.6-a}$$

$$c(t)^E = G(t) \left[\frac{1}{\alpha}\, \bar{\pi}\, e^{r(t-T)+\rho t}\right]^{\left[\frac{1}{\alpha-1}\right]} \quad \text{for } t \geq \hat{t} \tag{5.6-b}$$

Substitution of (5.6-a) and (5.6-b) into (5.4-c), and arranging terms, results in the following expression:

$$\left[\frac{1}{\alpha}\, \bar{\pi}\, e^{r(t-T)+\rho t}\right]^{\frac{1}{\alpha-1}} \left[\frac{1-\alpha}{\alpha}\right] [G(t) - F(t)] = [y^I(t) - y^E(t)] \tag{5.7}$$

Solving equation (5.3) gives the following:

$$K(t) = \begin{cases} K(t^0)\,e^{rt} + \int_{t^0}^{t} e^{r(t-s)}\,[y^I(s) - c^I(s)]\,ds & : \quad t < \hat{t} \\ K(\hat{t})\,e^{rt} + \int_{\hat{t}}^{t} e^{r(t-s)}\,[y^E(s) - c^E(s)]\,ds & : \quad t \geq \hat{t} \end{cases} \tag{5.8}$$

It follows for $K(T)$:

$$K(T) = \left[e^{r\hat{t}}\,K(t^0) + \int_0^{\hat{t}} e^{r(\hat{t}-s)}\,[y^I(s) - c^I(s)]\,ds \right] e^{r(T-\hat{t})} + \int_{\hat{t}}^{T} e^{r(T-s)}\,[y^E(s) - c^E(s)]\,ds \tag{5.9}$$

When $[G(t) > F(t)]$ and $y^I(t) > y^E(t)\ \forall t$, then it follows from (5.9) that $\dot{K}(t) > 0$ for $t < \hat{t}$ and $\dot{K}(t) < 0$ for $t \geq \hat{t}$. Accordingly, the migrant will accumulate savings while being abroad, and he will use up his stock of savings when back in his home country. This behavior of migrants is often referred to as *target saving* and it is a common feature of return migration.

Equations (5.6-a), (5.6-b), (5.7), and (5.9) determine the optimal paths' of consumption at home and abroad, $\hat{c}^E$ and $\hat{c}^I$, the stock of savings, $\hat{K}(t)$, and the time of return, $\hat{t}$.

For illustration, the problem will now be simplified to get an analytical solution for $\hat{t}$. Assume, for simplicity, that the stock of savings the migrant worker intends to hold in $t = T$, $K(T)$, is equal to zero: $K(T) = 0$. Denote the stock of savings at t^0 as K^0. Furthermore, set $y^I(t) = w^I$ and $y^E(t) = w^E$. This assumption implies that the migrant considers his wage level, either at home or abroad, as remaining at the same level over the whole time horizon considered. In other words, the migrant assumes his stock of human capital as constant over his future life. Finally, let the migrant base his decision on the current size of F and G: $G(t) = G$ and $F(t) = F$. Normalizing $t^0 = 0$, and setting $\rho = r = 0$ and $\alpha = 0.5$, equation (5.9) simplifies to:

$$K^0 + \hat{t}[w^I - w^E] + \hat{t}[c^E - c^I] + T\,[w^E - c^E] = 0 \tag{5.10}$$

Note that, under the above assumptions, it follows from (5.6-a) and (5.6-b) that the flow of consumption is constant in each country: $c^E(t) = c^E$ and $c^I(t) = c^I$. (5.7) may then be rewritten as:

$$\bar{\pi}^2 = \frac{1}{4}\,\frac{G - F}{w^I - w^E} \tag{5.11}$$

Denoting the wage differential $[w^I - w^E]$ as Δ and the differential of the environment indices, $[G - F]$, as Γ, and solving (5.6-a), (5.6-b), (5.10) and (5.11) for $\hat{t}$, one gets:

$$\hat{t} = \frac{T\,[G\Delta - w^E\,\Gamma] - K^0\,\Gamma}{2\,\Delta\,\Gamma} \tag{5.12}$$

The optimal time the migrant intends to further stay abroad is a function of the wage differential Δ, the differential of the environment indices, Γ, the lifetime horizon T and the stock of savings at $t = 0$, K^0. Totally differentiating (5.12) and rearranging terms results in the following expression:

$$d\hat{t} = \left[\frac{T\,w^E + K^0}{2\Delta^2}\right] d\Delta - \left[\frac{T\,G}{2\Gamma^2}\right] d\Gamma - \left[\frac{1}{2\Delta}\right] dK^0 + \left[\frac{\Delta\,G - \Gamma\,w^E}{2\,\Delta\,\Gamma}\right] dT \tag{5.13}$$

Accordingly, for $\Gamma > 0$ and $\Delta > 0$, the time the migrant intends to further remain in the host country depends positively on the wage differential Δ and his future lifetime horizon T. It depends negatively on the degree of attachment to the home country, relative to that of the host country, as represented by Γ, as well as on the accumulated stock of savings when the decision is taken, K^0.

5.3 Empirical Analysis

The data used for the empirical analysis are drawn from the first wave of the German Socio-Economic panel (1984). The panel comprises 4500 households of German nationality and 1500 households of foreign nationality. The vast majority of the latter group consists of so-called *guest-workers*, migrants with Spanish, Yugoslavian, Turkish, Greek and Italian nationality, who migrated to Germany mainly before 1973.[9] This migration was meant to be temporary by the German government and, at least initially, by the migrants themselves.

The panel contains information about all persons living in a respective household, as well as on the household as such. The data used for this analysis stem from the subsample of migrant workers, and concern only personal characteristics. The analysis is based on a question in the personal questionnaire which related to the foreigner's intention about how long to remain in Germany. Migrants were asked whether they would like to stay in Germany forever, or whether they want to return to their home countries in either the next 12 months or in some years. Those who replied that they intend to return in some years time were further requested to specify the number of years they want to remain in Germany.

According to this information, the stock of migrants in the sample can be separated into two groups: those who want to stay permanently in Germany (452), and those who want to return to their home countries after a specific number of years (1282).

Consider these two groups on the basis of the above theoretical analysis. For those migrants who would like to stay forever the solution of the optimization problem in section 5.2 would be a corner solution ($\lambda(t) = 1 \, \forall t, t \in \{t^0, T\}$). On the other hand, for those who specify the number of years they would like to stay in Germany before returning, the solution of the above optimization problem would be an interior one. According to equation (5.13), differences in the number of years a migrant wants to remain before returning home are explained by differences in the perceived environment at home and abroad, Γ, individual wage differentials between home- and host country, Δ, the remaining lifetime horizon, T, and the amount of savings allocated so far, K'^0. Accordingly, for the latter subgroup the theory provides hypotheses for the qualitative impact of a set of explanatory variables on the migrant's decision. The theory also implies that those factors which have a positive effect on the time the migrant decides to stay further in Germany should help to differentiate among the two subgroups of those who want to stay forever, and those who want to return sometime in the future.

[9] For some details on guest-worker migration to Germany, see Mehrlaender (1980) and Chapter 2.

5.3.1 Estimation Methods

For the empirical analysis, each of the environmental factors will be characterized by a vector of variables available in the data set. The analysis will be conducted in two steps:

First, logit models will be estimated to determine the impact of a set of explanatory variables on the probability that a migrant will want to return to his home country. Secondly, and using only the subset of those migrants who intend to return, a duration analysis on the time the migrant still wants to remain in Germany will be performed.

Logit Analysis

The logit specification may be derived directly from the underlying theory. Define a dichotomous variable Y which takes the value 1 when the migrant does not want to return, and 0 otherwise. Should the migrant meet his decision right at the point of the interview, then Y is determined by:

$$Y = \begin{cases} 1 & \text{if} \quad T - \hat{t} > 0 \\ 0 & \text{if} \quad T - \hat{t} \leq 0 \end{cases} \tag{5.14}$$

where $\hat{t}$ and T are defined as in section 5.2. Assuming a linear relation between $\hat{t}$ and a vector of explanatory variables, and introducing an additive random component u, one gets:

$$T - \hat{t} = \alpha' X - u\,; \quad X' = [1, \Delta^*, \Gamma^*, K^{0*}, T^*] \tag{5.15}$$

where $\Delta^*, \Gamma^*, K^{0*}, T^*$ are empirical specifications of Δ, Γ, K^0, T. It follows that the probability that a migrant stays is given by:

$$P(Y = 1) = P(\alpha' X - u > 0) = F\left(\frac{\alpha' X}{\delta}\right) \tag{5.16}$$

where δ is used to standardize the random variable u and F is the CDF of u/δ. Assuming u/δ to have a logistic distribution with mean 0 and variance $\pi/3$, the logit model evolves:

$$P(Y = 1) = \frac{exp(\theta' X)}{1 + exp(\theta' X)} \tag{5.17}$$

where the estimated parameter vector is given by $\theta = (\alpha/\delta)$.

Duration Analysis

The second step of the analysis relates only to the subsample of those who want to return after a specific number of years.

The remaining intended duration of stay in the host country and, afterwards, the time back at home may be considered as two states which will sequentially be occupied by the migrant worker. At the point of expected return, a transition between these two states takes place. Given a migrant population, it is now of interest to investigate how these transitions, or, in other words, completions of spells, are distributed over time and how they depend on individual characteristics of the migrant. Remember that the analysis is performed on expectations of remaining durations, not on actually performed durations. Furthermore, the data available are data on the current stock of migrants in 1984. The estimates refer therefore to the (possibly selected) population of migrants in Germany in 1984, not to the population of migrants entering Germany at any one time.

The appropriate analytical tools are provided by the hazard function method, or transition analysis. The central concept of these methods is the *hazard* function $\xi(t)$. Applied to the problem on hand, the hazard $\xi(t)$ would be defined as the conditional probability that a migrant's intended further duration of stay, τ, will end in t, given that it lasts until t (in continuous time):

$$\xi(t) = \lim_{dt \to 0} \frac{P(t \leq \tau \leq t + dt | \tau \geq t)}{dt} = \frac{f(t)}{1 - F(t)} = \frac{f(t)}{S(t)} \tag{5.18}$$

In (5.18), $f(t)$ is the density function of the random variable τ, $F(t)$ is the distribution function and $S(t)$ is usually referred to as the *survivor* function. In parametric hazard models, $F(t)$ is known up to a vector of unknown parameters which has to be estimated. An estimate of the hazard function is then easily constructable. However, the underlying population is, especially in economic applications, not always homogeneous. The hazard, although following the same distribution, may vary among individuals with different characteristics. To take account of such heterogeneity in the underlying sample population, the parameters of the distribution may be made functions of a vector of explanatory variables, or covariates.

The parametric approach imposes a strong restriction on the hazard: it has to follow a certain pattern as predetermined by the underlying distribution. Parametric methods are therefore justified only when the choice of the distribution of τ, $f(t)$, is based on some economic theory. Although the deterministic theoretical model of section 2 provides some guidance regarding the choice of covariates and their qualitative

impacts, it does not help to justify any distributional assumptions. Furthermore, parametric models impose a smooth shape on the baseline hazard function. This, however, contrasts with the lifetable estimates, as depicted in figure 1.

Therefore, two methods are chosen here that allow the estimation of the impact of covariates on the hazard without imposing strong restrictions on the behavior of the hazard over time: the proportional hazard model, as proposed by Cox (1972), and the piecewise constant exponential model. The latter method, though being parametric, is very flexible and should yield results that are similar to those of the non-parametric approach.

Cox's Proportional Hazard Specification

A proportional hazard is defined as:

$$\xi(X,t) = \phi(X,\beta)\,\xi_0(t) \tag{5.19}$$

where X is a vector of covariates, β is a parameter vector and ξ_0 is usually referred to as the *baseline hazard.* When X is time invariant, which will be the case throughout the analysis, the proportional hazard specification implies that the quotient of the hazards of two individuals with regressor vectors X_1 and X_2 is constant for all t and equal to $\phi(X_1,\beta)/\phi(X_2,\beta)$.

Cox (1972, 1975) suggested the method of partial likelihood to estimate the unknown parameter vector in $\phi(X,\beta)$, without specifying the form of the baseline hazard $\xi_0(t)$. The main idea of this method is that, when no information about the baseline hazard is available, only the order of the durations are used to infer the unknown coefficients of the covariates.[10]

The specification chosen here for $\phi(X,\beta)$ is: $\phi(X,\beta) = exp(X'\beta)$. When no spells are censored (which is the case for the duration data used here), and when the completed durations are ordered, $\tau_1 < \tau_2 < \tau_3 < ... < \tau_N$, the partial likelihood may be written as a function of the parameter vector β:

$$L^P(\beta) = \prod_{i=1}^{N} \left[\frac{exp(x_i'\beta)}{\sum_{j=i}^{N} exp(x_j'\beta)} \right] \tag{5.20}$$

where the term in brackets is the conditional probability that observation i concludes a spell at τ_i, given that any of the remaining observations $j > i$ could have ended a

[10]The method is described in detail in Lancaster (1990).

spell at τ_i. The partial likelihood function as depicted in (5.20) corresponds to the likelihood function estimated here.

It should be noted that Cox's partial likelihood method is problematic if more than one individual experiences an event in the same time interval (tied ending times). As it is obvious from table 5.4 in the appendix, this is the case with the data used here. With tied data, the exact calculation of the partial likelihood becomes very complicated. Approximate formulas reduce in this case the computational burden. The approximation used here is that proposed by Breslow (1974). However, the adequacy of such approximations is sometimes questioned.[11] To check the validity of the results for the continuous Cox model, discrete time models are additionally estimated. The method and the results are outlined in the appendix.

Piecewise Constant Hazards

The piecewise constant hazard specification is based on the exponentially parametric model. However, unlike the exponential model, which implies a constant hazard over the entire horizon considered, the piecewise exponential model allows the hazard to change between predetermined time intervals. The method is therefore appropriate when the underlying theory does not justify any distributional assumptions on τ.

In the piecewise-constant formulation, the hazard may be written as:

$$\xi^P(X,t) = \phi(X,\beta)\, exp(\xi_i); \quad n_{i-1} \leq t < n_i;\ i = 1,...,m;\ n_0 = 0,\ n_m = \infty \qquad (5.21)$$

where m is the number of time intervals chosen and $(n_i - n_{i-1})$ is the length of the i^{th} interval. Note that the intervals do not have to be of equal length. The baseline hazard $exp(\xi_i)$ is constant over the interval $[n_{i-1}, n_i)$ and determined by the parameters ξ_i, which have to be estimated. The specification of the intervals follows from table 5.4 in the appendix. Data points on the expected duration clump at 5, 10, 15 etc years. The intervals for the piecewise constant specification are chosen so as to contain these critical numbers. $\phi(X'\beta)$ is some functional form of time-invariant covariates, with unknown parameter vector β. The specification used here is the same as for the Cox model: $\phi(X'\beta) = exp(X'\beta)$.

In the piecewise constant model, density- and survivor functions have discontinuities at the limits of the respective intervals. For time invariant regressors, the piecewise constant hazard is (piecewise) proportional.

[11] See, for example, Farewell and Prentice (1980).

The hazard specifications in (5.21) and (5.19) are similar: both are proportional, and the baseline hazard in the Cox model, $\xi_0(t)$, corresponds to the piecewise constant baseline hazard $exp(\xi_i)$ in the exponential specification. The interpretation of the vector of coefficients is accordingly analogous in both specifications: $\beta^c = (\delta ln\xi^c)/(\delta X)$ and $\beta^p = (\delta ln\xi^p)/(\delta X)$, where β^c and β^p denote the coefficient vectors in the piecewise constant and the Cox model, respectively. The estimated coefficients indicate therefore the percentage change in the hazard when the respective variable changes by one unit.

Some Remarks

Before proceeding, some remarks on the interpretation and comparability of the results in the two steps of the analysis seem appropriate. The logit analysis differentiates between two groups: those migrants who want to remain in Germany, and those migrants who want to return home at some future point in time. However, a migrant who replies that he wants to remain in the host country may have made this decision a long time before the interview. Therefore, measured characteristics of this migrant at the time of the interview are not necessarily those that determined his decision, when this decision has been taken in the past and when the relevant variables change over time. In other words, the probability of return may not be sensitive to all those factors implied by the theoretical considerations above. On the other hand, the number of years migrants want to stay before returning should be sensitive to the respective factors as they are measurable at the time of the interview. Accordingly, the explanatory value of the same set of variables may well differ in the two stages of the analysis.

5.3.2 Data and Specification of Variables

The logit analysis is based on migrant workers with Italian, Spanish, Yugoslavian, Turkish, and Greek nationality, full-time employed, part-time employed or unemployed at the time of the interview, who specify whether or not they want to return to their home countries. After excluding all observations with missing values in relevant variables, the final number of observations used for the analysis reduces to 1734.

The duration analysis is based on the subset of those who intend to return home and who specify the time they wish to remain in Germany. Migrants could respond that they wish to return in the next 12 months or they could indicate a number of years. The duration variable DUR is set equal to one when the migrant wants to return in the next 12 months, otherwise it takes the value of the number of years specified. The

number of observations available for the analysis is here 1094.[12]

Environment

The environmental differential Γ is represented by the following set of variables: the variable TRANSFER is a dummy variable and equal to 1 when the migrant transfers money back to his home country. PARTNER is a dummy variable that takes the value 1 when the migrant's partner is living in Germany. Both variables are indicators for social links to the home country. HSP and GSP are dummies that are equal to 1 when the migrant speaks the home country language or the host country language well or very well, respectively. The knowledge of the German language may be an indicator for the migrant's integration potential (or, likewise, his integration) into the foreign society. Good or very good knowledge of the host country language could be an indicator for the link to the home country environment. The dummies SCHOOL and EDU assume the value 1 when the migrant attended a school in Germany or when he undertook a job-specific education in Germany. Finally, the variable YSM describes the years since migration. This variable may be an indicator for how much the migrant has alienated from his home country environment and adjusted to that of the host country.

Wage Differentials

The second factor that should influence the migrant's decision is the perceived earnings differential between host- and home country.[13] Any decision of the migrant is based on the subjectively perceived earnings differential, which could be constructable were the migrant to have been asked about how much he expects to earn back home. However, the only data that are available are earnings in Germany of those who were employed at the time of the interview.

To construct an approximation for the individual, potential earnings differential of migrant workers, an earnings variable for those who are unemployed has first to be created. This could be done by estimating a human capital earnings equation for employed workers and using the coefficients of the estimation equation to predict earnings of those who are unemployed. However, such a procedure may possibly result in a sample selection bias. Therefore, the predictions of earnings for the unemployed are constructed by using a two-stage estimation procedure, as suggested by Heckman

[12] 188 of those migrants who answered that they wish to return (1282) did not specify how long they want to remain in Germany. They therefore had to be excluded from the duration analysis.

[13] Note that, for the migrant's decision, only expectations matter, not possible realizations.

(1979). The method is outlined in the appendix. Estimation results are given in table 5.5 in the appendix. The predicted earnings series is then used as an approximation of earnings potentials of unemployed migrants.

As a second step, earnings differentials have to be constructed. Data on earnings potentials of individual migrants in the home countries are not available, but only their earnings in Germany and their nationality. Under some assumptions it is, however, possible to construct from these information approximations of earnings differentials.

Denote the earnings of some migrant i with a given stock of human capital in Germany as EG_i, and the earnings he would receive back home as EH_i. Assume that when migrant A from country j receives earnings in Germany that are x_j% higher than those of migrant B from country j, then Mr. A receives back home earnings that are likewise x_j% higher than those Mr. B would receive.[14] This implies:

$$x_j = \frac{EG_i - EH_i}{EG_i} \tag{5.22}$$

Under the assumption that x_j is constant for all migrants from country j, the perceived earnings differential of some migrant i from country j, with earnings EG_i in Germany, may be formulated as:

$$(EG_i - EH_i) = x_j\, EG_i \tag{5.23}$$

Define a country index k, $k = 1, ..j, ..n$, and a dichotomous variable d_k, where d_k equals 1, should some migrant's home country be $k \neq j$, and 0 otherwise. Assuming linearity, the effect of the wage differential may be formulated as:

$$\beta_1\, x_k\, EG_i + \beta_k\, d_k\, x_k\, EG_i \tag{5.24}$$

The coefficient β_1 captures the impact of the wage differential, perceived by migrant i from country k, on his decision. However, a perceived wage differential of the same size may affect two migrants differently, when they come from different countries. Reasons for this could be different costs of living in the two emigration countries, additional payments, tax systems, working conditions etc. The impact of this second effect is represented by the coefficient β_k.

[14] In other words, earnings in either country are a linear function of the stock of human capital. Assume that the stocks of human capital of Mr. A and Mr. B are given by H_A and H_B, respectively, with $H_A > H_B$. Assume further that the rental rate on a unit of human capital in the host country is given by r^G and that in the home country by r^E. Then (5.22) implies that $r^H\, H_A / r^G\, H_A = r^H\, H_B / r^G\, H_B$ = constant for each pair of countries G, E.

For the empirical analysis, country j will now be defined as *base country*. It follows for x_k: $x_k = x_j + (x_k - x_j)$.

Inserting this into (5.24):

$$\beta_1 x_j EG_i + [\beta_k x_k d_k + \beta_1 (x_k - x_j)] EG_i = \xi_{1j} EGi + d_k \xi_{2k} EG_i \tag{5.25}$$

Relation (5.25) is constructable when only dummies on migrants nationalities are available. However, without information on x, the structural coefficients β_1 and β_k are not identifiable. The sign of the coefficient ξ_{2k} therefore depends on the difference in wage situations in country j and country k, and, furthermore, on the difference in the reaction between migrants from country k and the base country j.

Time Horizon

Equation (5.13) implies that the length of the time horizon T has a positive impact on the expected duration. A natural approximation for T would be the age of the migrant worker. The theory suggests then that an increase in age should have a negative impact on $\hat{t}$.

Labor Market Situation

To capture the impact of the migrant's labor market experience, two variables are included in some specifications: UNEMP is a dummy variable that equals 1 when the migrant is unemployed, and UNEMP10 is a dummy that is equal to one when the migrant was unemployed at least once over the last 10 years.

Additionally, control variables are included for sex and marital status: the variable MALE equals one when the migrant is male, and the variable MARRIED equals one when the migrant is married.

Table 5.1 presents characteristics of the total sample population and of the subsamples of those who intend to stay and who intend to return. The last line indicates that 74% of the sample population intends to return home sometimes in the future.

An average of 14.5 years since migration signifies that the stock of the migrant population resides in Germany for a considerable amount of years. Columns (2) and (3) show that stayers are, on average, more than one year longer in Germany than returners. Average gross earnings of those who want to stay are slightly higher than of those who want to return. A higher percentage of migrants who intend to stay is male

Table 5.1: Sample Characteristics, 1984. Whole sample and subsamples of those who wish to stay and who wish to return

VARIABLE	*Whole Sample*		*Wish to Stay*		*Wish to Return*	
	Mean	SD	Mean	SD	Mean	SD
MONTHLY GROSS EARNINGS (DM)	2413	*728*	2477	*753*	2391	*719*
YEARS SINCE MIGRATION	14.4	*5.1*	15.41	*5.5*	14.22	*4.91*
AGE	38.86	*10.9*	38.39	*10.9*	39.02	*10.9*
MALE	0.67	*0.46*	0.72	*0.44*	0.66	*0.47*
MARRIED	0.82	*0.38*	0.76	*0.42*	0.84	*0.36*
TRAINING IN GERMANY	0.12	*0.32*	0.14	*0.35*	0.11	*0.32*
SCHOOLING IN GERMANY	0.17	*0.37*	0.2	*0.39*	0.16	*0.36*
GOOD OR VERY GOOD GERMAN	0.41	*0.49*	0.54	*0.50*	0.37	*0.48*
GOOD OR VERY GOOD MOTHER TONGUE	0.92	*0.26*	0.88	*0.33*	0.94	*0.23*
TRANSFERS	0.44	*0.49*	0.29	*0.45*	0.49	*0.50*
PARTNER IN GERMANY	0.76	*0.42*	0.74	*0.44*	0.77	*0.42*
UNEMPLOYED LAST 10 YEARS	0.29	*0.45*	0.29	*0.45*	0.29	*0.45*
UNEMPLOYED	0.093	*0.29*	0.080	*0.27*	0.098	*0.30*
SAMPLE SIZE	1734		452		1282	

SOURCE: Socio-Economic Panel, wave 1, 1984.

and a lower percentage is married. Transfer of money back home is considerably more common in the subsample of returners: 49%, compared with 29% in the subsample of stayers. More than half of those who want to stay speak the German language well or very well, compared with only 37% of those who wish to return.

5.3.3 Results

Logit Analysis

The results of the logit specifications are given in table 5.2.[15] The dependent variable equals one when the migrant intends to return, and 0 otherwise. The estimated coefficients indicate the impact of the respective variable on the probability that the migrant wants to return home.[16]

The impact of earnings are captured by the variables GEARN and GEARNK, $k = T, S, G, I$, where the capital letters indicate Turks, Spaniards, Greeks, and Italians, respectively. The base group are Yugoslavians. The interpretation of the estimated coefficients as the impact of earnings differentials corresponds to the assumptions above. Since in 1984 wages in all industrial and agricultural sectors were lower in the respective emigration countries than in Germany[17], the quotient x should be positive for all countries considered. It follows for the Yugoslavian base group that an increase in earnings in Germany and, according to the above assumptions, a rising wage differential should have negative effects on the return probability. This is compatible with theoretical considerations. The impact of a given earnings differential on the return probabilities of migrants from the other 4 countries is easily calculable by summing up the coefficients on GEARN and GEARNK. According to (5.25), the resulting expression is equal to $(\beta_1 + \beta_k d_k) x_k$, where β_k corresponds to the difference of the impact of some given differential between a Yugoslavian worker and a worker from country k. Referring to the results in column (2), this coefficient is positive only for Greek nationals. However, this does not mean that Greek nationals are acting contrary to what the theory would imply. As indicated above, the individual return probability is not necessarily very sensitive to the explaining variables, when these variables change over time and when the decision to return has been taken sometime in the past. This is definitely the case for earnings differentials. It should further be kept in mind that the

[15]The results of the logit analysis were obtained by using W. B. Greene's *LIMDEP* and the results of the transition analysis by using *TDA*, written by G. Rohwer.

[16]In what follows, this probability will be referred to as return probability. Note, however, that it is in this context the probability of *expected* return.

[17]see, e.g., Yearbook of Labour Statistics, 1988.

interpretation of the coefficients as the sensitivity of return probabilities on changes in earnings differentials underlies quite restrictive assumptions.

All variables representing the environmental differential have the expected sign and are mostly significant. The negative coefficient on the variable YSM indicates that the return probability of a migrant worker decreases with the number of years he resides in Germany. Furthermore, the probability of return is lower for those who speak a good or very good German (GSP), and whose partner is living in Germany (PARTNER). On the other side, a good or very good knowledge of the home country language (HSP) increases the return probability, as does the circumstance that the migrant transfers a part of his earnings back home (TRANSFER).

Keeping everything constant, and setting the return probability to the average sample return probability $\hat{p} = 0.65$, the results in table 5.3.3 indicate that males have a return probability which is about 7 percentage points lower than that of females.[18] A reason for this result may be that male immigrants integrate more easily into the foreign society. Males may further be more concerned about their economic future than females and, accordingly, evaluate economic stability and working conditions higher than females.

The coefficient on the variable AGE should denote the impact of the remaining lifetime horizon on the migrant's return probability. AGE is, however, only significant in the first model specification (column 1). Upon introducing environmental variables (column (2) and (3)), AGE becomes insignificant, indicating that this variable only captures environmental factors, but not the impact of the remaining lifetime horizon on the migrant's decision. This is not surprising. As for earnings, age changes over time, so that the migrant's age at the time of the interview may contain little information about the impact of the lifetime horizon on the decision to stay when this decision was actually taken.

Column (3) presents results when dummies for the past and current employment situation are introduced. Having been unemployed at least once during the last 10 years (UNEMP10) has no significant impact on the probability to return. However, those who are unemployed at the time of the interview (UNEMP) want to return with a significantly higher probability than those who are in the work force. This effect is relatively large: again evaluated at $\hat{p} = 0.65$, and keeping everything else constant, the return probability of unemployed migrants is 20% higher than that of their employed colleagues. This result contradicts the common view that migrants take advantage of the favorable German benefit system and would therefore rather prefer to be unem-

[18] It follows from the logit specification (5.16) that $dp/dx = p(1-p)\theta$.

Table 5.2: Logit Analysis, Return Decisions

VARIABLE	(1)	(2)	(3)
CONSTANT	**1.35**	**1.73**	**1.79**
	(5.05)	(3.35)	(3.38)
EARN	**-0.22**	**-0.25**	**-0.29**
	(-2.32)	(-2.58)	(-2.89)
EARNT	**0.25**	**0.21**	**0.20**
	(4.06)	(3.27)	(3.09)
EARNG	**0.38**	**0.35**	**0.35**
	(4.87)	(4.24)	(4.23)
EARNS	**0.18**	**0.14**	**0.13**
	(2.46)	(1.82)	(1.76)
EARNI	**0.10**	**0.14**	**0.14**
	(1.57)	(2.13)	(2.08)
YSM	**-0.077**	**-0.061**	**-0.062**
	(-5.38)	(-4.02)	(-4.06)
AGE	**0.017**	**0.007**	**0.006**
	(2.64)	(0.88)	(0.749)
MALE	**-0.24**	**-0.34**	**-0.31**
	(-1.65)	(-2.29)	(-2.04)
MARRIED	**0.53**	**0.40**	**0.43**
	(3.43)	(2.35)	(2.55)
EDU		**0.044**	**0.019**
		(0.21)	(0.09)
SCHOOL		**0.21**	**0.19**
		(0.94)	(0.84)
GSP		**-0.47**	**-0.46**
		(-3.67)	(-3.56)
HSP		**0.74**	**0.74**
		(3.69)	(3.69)
TRANSFER		**0.85**	**0.89**
		(6.53)	(6.80)
PARTNER		**-0.77**	**-0.77**
		(-2.21)	(-2.20)
UNEMP10			**-0.10**
			(-0.74)
UNEMP			**0.58**
			(2.45)
Log – Likelihood	-951	-907	-904
No. of Obs.	1734	1734	1734
Return	1282	1282	1282
Stay	452	452	452

SOURCE: Socio-Economic Panel, wave 1, 1984.
Note: t-ratios in parenthesis. Coefficients of earnings variables are multiplied by 1000.

ployed in Germany than returning home.

Duration Analysis

The estimated coefficients on the covariates for the duration models are reported in table 5.3. Note again that this analysis is performed only on the subsample of those who intend to return home, and who additionally specified the number of years they still want to remain in Germany. Furthermore, note that the analysis relates to expected future durations of a stock of migrant workers in 1984, not to completed durations.

Both duration models are of the proportional hazard form. Therefore, the coefficients can be interpreted as the constant proportional effect of the respective variable on the conditional probability of completing a spell. In other words, the coefficients indicate the percentage change in the hazard, when the respective variable changes by one unit.

A global goodness-of-fit test as proposed by Moreau, O'Quigley and Mesbah (1985) was performed to assess the validity of the proportional hazard model. The basic idea of the test is to check whether the effect of the covariates, which under the proportional hazard assumption is constant and measured by θ, varies as a step function between time intervals. To test the null hypothesis of a proportional hazard, Moreau, O'Quigley and Mesbah propose a score test. Under the null hypothesis, the appropriate test statistic is asymptotically χ^2 distributed, with degrees of freedom equal to the number of parameters.[19] The same definition of intervals as for the piecewise constant formulation is used, except for the last interval.[20] The test statistics for the small and the large model specifications (Columns (3) and (4) in table 5.3) are then given by 55.31 (45) and 85.66 (85), with degrees of freedom in parenthesis. Therefore, the null hypothesis of the validity of the proportional hazard specification can not be rejected in both cases.

The first two columns in table 5.3 report the results of specifications of the piecewise constant model.[21] Column (3) and (4) present estimated coefficients of the Cox models. As could be expected, the coefficients of the respective specifications for the Cox models and the piecewise constant models are similar in size.

[19]Since it is supposed that the effect of covariates differs between intervals, the number of parameters equals the number of covariates times the number of intervals chosen.

[20]Since the last interval contains not enough observations, the test breaks down when performed over all intervals. Therefore, the last two intervals are merged to one interval.

[21]Coefficients of the piecewise constant baseline hazards are reported in table 5.5 in the appendix.

Table 5.3: Duration Analysis

	Piecewise Constant		Cox	
Variable	(1)	(2)	(3)	(4)
Earn	-0.145	-0.163	-0.130	-0.120
	(-2.63)	(-2.78)	(-2.23)	(-2.36)
Earnt	0.107	0.095	0.080	0.092
	(3.14)	(2.66)	(2.68)	(2.23)
Earng	0.089	0.090	0.065	0.065
	(2.17)	(2.17)	(1.61)	(1.59)
Earns	-0.050	-0.047	-0.047	-0.046
	(-1.18)	(-1.04)	(-1.07)	(-1.02)
Earni	0.050	0.066	0.058	0.046
	(1.22)	(1.57)	(1.13)	(1.39)
Ysm	-0.023	-0.023	-0.020	-0.021
	(-2.92)	(-2.78)	(-2.58)	(-2.48)
Age	0.021	0.020	0.019	0.018
	(5.57)	(4.47)	(5.12)	(4.09)
Male	0.084	0.067	0.062	0.048
	(1.09)	(0.83)	(0.80)	(0.59)
Married	-0.077	0.309	-0.084	0.25
	(-0.82)	(2.10)	(-0.90)	(1.72)
Edu		-0.021		-0.017
		(-0.18)		(-0.14)
School		0.061		0.063
		(0.49)		(0.51)
Gsp		-0.058		-0.062
		(-0.83)		(-0.90)
Hsp		-0.092		-0.067
		(-0.71)		(-0.51)
Transfer		0.139		0.120
		(2.06)		(1.79)
Partner		-0.361		-0.314
		(-3.06)		(-2.68)
Unemp10		0.082		0.063
		(1.07)		(0.81)
Unemp		0.347		0.318
		(2.83)		(2.60)
No. of Obs.	1094	1094	1094	1094
Log – Likelihood	-3008	-2993	-6728	-6717

SOURCE: Socio-Economic Panel, wave 1, 1984. Note: t-ratios in parenthesis. Coefficients of earnings variables are multiplied by 1000.

The coefficients of the earnings variables are all multiplied by 1000. Estimates of both the Cox- and the piecewise constant specifications indicate that an increase in earnings has a negative impact on the hazard for all nationalities. This impact is largest for Yugoslavian and Spanish workers. Remember that this may be due to the size of x_k. It may as well be due to different effects of a given earnings differential on decisions of migrants with different nationalities, as denoted by β_k. The qualitative impact of earnings on the hazard is consistent with the theory.

The variable AGE is strongly significant in all specifications. Different from the logit results, AGE remains here significant when environmental variables are included. The coefficient may be interpreted as the impact of a change in the lifetime horizon on the migration decision. Referring to column (3), being 1 year older, which corresponds to a reduction of a fixed lifetime horizon by one year, increases the hazard by 1.9%. The size of this effect is similar in all specifications.

Turning to the environmental variables (column (2) and (4)), both a good or very good knowledge of the German language and the home country language do not influence the hazard significantly. Remember that these variables significantly influenced the return probability in the logit analysis above.

The coefficients on the variables SCHOOL and EDU are not significant as they were neither in the logit specification. Accordingly, visiting a school in Germany or getting a job specific education seems not to have an impact on the migrant's duration decision or his return probability.

The coefficient on the variable PARTNER is negative and significant. Consequently, having a partner in Germany decreases the conditional probability of ending a spell at some t. On the other side, transferring money home increases this probability (see coefficients on TRANSFER). As the coefficients on the variable YSM indicate, each additional year the migrant has been in Germany decreases the hazard by 2.3% (exponential) or 2.1% (Cox). The qualitative impact of all these variables corresponds to what the theoretical model suggested.

Being male (MALE) does not affect the hazard. This is in contrast to the findings of the logit specifications, where males had a lower return probability than females. The coefficient on the variable MARRIED is negative, but insignificant in specifications (1) and (3). It is positive and significant when introducing environmental variables.

The fact that the migrant has been unemployed at least once during the past 10 years (UNEMP10) has no significant effect on the hazard. However, being unemployed at the time of the interview (UNEMP) increases the hazard. The effect is considerable: The conditional probability that an unemployed migrant wishes to return at some t

is more than 30% higher than that of a comparable migrant who is employed at the time of the interview. Again, this result is contrary to the assertion that migrants take advantage of the benefit system. An unemployed migrant has a higher conditional probability to return at an early stage than a comparable employed colleague.

Figures 2 and 3 illustrate the survivor function for the Cox model and the hazard function for the piecewise constant exponential model (for male, turkish workers with age and earnings set to the sample mean and all dummies set to zero).

5.4 Conclusion

The subject of this study is the analysis of return decisions of migrant workers. Section 5.2 presents a theoretical analysis on the migrant's savings- and return decisions. The model explains common features of return migration, like the accumulation of savings while being abroad. The time the migrant intends to remain further abroad (and, at the extreme, the decision to stay permanently) is shown to depend basically on 4 factors: the migrant's earnings potential at home, relative to what he earns abroad, the migrant's perception and evaluation of environmental factors, such as family, friends, social regulations etc., at home relative to those abroad, the migrant's remaining lifetime horizon, and his stock of savings accumulated at the time of decision making.

The qualitative implications of the theory are empirically tested, using data from the first wave of the German Socio-Economic panel. The empirical analysis is based on the information about whether the migrant intends to return or not, and, in the case of intended return, on the number of years he still wishes to remain in Germany.

As a first step, and using the whole sample of those who want and who do not want to return, logit models are estimated, where the dependent variable is the decision of the migrant whether or not to return. As a second step, and considering only the subset of those who wish to return, a duration analysis is performed. The spell variable is the migrant's intended further duration of stay in the host country. In both stages, the empirical results are found to be mostly consistent with predictions of the theoretical model.

The logit analysis reveals that the time of residence in Germany significantly reduces the return probability, as does the presence of the partner, and the ability to speak the German language well or very well. Males are less probable to return than females. The fact of being married increases the return probability. Results on the impact of variables that capture earnings differentials and the lifetime horizon are inconclusive. The reason may be that the decision to return is likely to have been

taken some time before the interview. If those variables that capture characteristics which influenced the migrant's decision in the past are measured with a considerable lag, as it may be the case here, and if, additionally, they change over time, they may not represent their impact on the past decision. Finally, being unemployed at the time of the interview has a positive effect on the return probability.

For the duration analysis, two specifications are chosen that do not impose strong restrictions on the baseline hazard: the Cox model and the piecewise constant exponential model. The results support the hypothesis that higher earnings differentials are reducing the hazard. Furthermore, the coefficients of the variable AGE are here significant and have the expected sign. This indicates that a longer future lifetime horizon decreases the conditional probability to leave the country at some t.

Variables that represent the environmental factor have, should they be significant, the expected sign. Furthermore, those who are unemployed at the time of the interview have a higher conditional probability to return at an early stage than their employed colleagues.

The analysis provides some evidence that migrants return decisions are endogenous outcomes of an intertemporal optimization of lifetime utility. The understanding of the structure of this decision procedure is important to develop efficient migration policies. This study is an attempt to provide some insight into these decision processes.

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5.5 Appendix

Appendix 1: Potential Earnings of the Unemployed

Earnings are only observable for those migrants who are in the labor force. This group may be a selected subsample of the whole population of employed and unemployed workers. Therefore, predictions of earnings of unemployed migrants, based on simple OLS estimates of coefficients of earnings equations for the employed, may not correctly tell what a currently unemployed worker with a given vector of characteristics would earn. To see this, define a variable I_i:

$$I_i = \begin{cases} 1 & : \text{ migrant } i \text{ employed} \\ 0 & : \text{ migrant } i \text{ unemployed} \end{cases}$$

Consider further the following relation:

$$y_i = \beta' x_i + u_i$$

The variable y_i may denote earnings and x_i are individual characteristics and human capital variables. β is a parameter vector and u_i is a normally distributed error term. Earnings are only observed for those who are employed. It follows that for these cases:

$$E(y_i) = \beta' x_i + E(u_i | I_i = 1) \tag{5.26}$$

Only when the process which selects individuals into the unemployment pool is independent from u_i, no selection bias will arise. To account for possible selection bias and to correctly predict the potential earnings of those who are unemployed, a simple two step procedure as proposed by Heckman (1979) is used. This procedure basically introduces a further variable, call it λ, in the regression equation so as to ensure that the last term in (5.26) vanishes.[22] In the first step, a probit specification is estimated on the probability that a person is unemployed. Estimation results are then used to calculate an estimate for λ, which will be added to the regressors of the OLS specification.

[22]When the selection rule is described by a simple probit model, it can be shown that $E(u_i | I_i = 1) = -\sigma[f(z_i \delta)/F(z_i \delta)] = -\sigma \lambda_i$, where $f(.)$ and $F(.)$ are the density function and the distribution function of a standardized normal random variable, z is a vector of variables which explains the selection process and δ the corresponding parameter vector. σ is then the covariance between the OLS error term and the standard normal random variable of the probit specification. It is now easy to see that the addition of the new variable λ_i among the regressors implies a new error term $\epsilon_i = u_i + \sigma \lambda_i$, with expected value equal to zero.

In the second step, OLS estimation yields parameter estimates that are unbiased and consistent.[23]

Coefficient estimates are given in table 5.6. The variables SCH and TRAIN denote years of schooling and job specific education, respectively, both measured after the age of 14. The variables YEMP and YEMPSQ are years of full employment and the square of years of full employment, respectively. The variables YSM and YSMSQ are years since migration and the square of years since migration. The dummy variable PART is equal to one when a person is part-time employed, and TUR, JUG, ITA and GR are dummy variables for Turkish, Jugoslavian, Italian and Greek nationality, respectively. All other variables correspond to the notation used above.

Appendix 2: Discrete Time Complementary Log-Log Models

As indicated above, the estimation of a continuous time Cox model is problematic when survival times have ties. Although algorithms exist (and are used above) to approximate the partial likelihood when dealing with tied data, it seem advisable to check the validity of the results by reestimating some discrete versions of the Cox model.

Following Allison (1982), the discrete-time hazard function that corresponds to the continuous time proportional hazard function is given by

$$\xi_t = 1 - \exp\left[-\exp\left(\alpha_t + \theta' X_t\right)\right] \tag{5.27}$$

The set of constants α_t (t=1,2,..) can be left unspecified. Following Mantel and Hankey (1978), α_t will here be expressed as a polynomial in t. The model will then be estimated by maximum likelihood.[24] The results for different degrees of the polynomial are given in table 5.7. The significant coefficients are similar in size and in sign to those obtained from the continuous Cox model.

[23]Note that the error terms of the extended OLS regression are heteroscedastic. Furthermore, standard t-tests which are based on the OLS standard errors do not help to correctly assess the significance of the results, since some of the explanatory variables are estimated (see, for example, Madalla (1983)). Reported t-statistics are based on the correct, asymptotic standard errors (for the derivation, see Greene (1981)).

[24]For a derivation of the appropriate ML-estimator, see Rohwer (1991).

Appendix 3: Tables

Table 5.4: Intended Durations

PERIOD	YEARS	FREQUENCY
1	1	119
	2	140
2	3	128
	4	64
3	5	170
	6	70
4	7	23
	8	37
	9	8
5	10	202
	11	3
	12	5
	13	8
6	15	62
	16	3
	17	1
	18	4
	20	37
7	25	3
	26	2
	28	1
	30	4
SUM		1094

SOURCE: Socio-Economic Panel, wave 1, 1984.

Table 5.5: Piecewise Constant Hazards

VARIABLE	(1)	(2)
ξ_1 (PERIOD 1)	**-2.55**	**-2.53**
	(-15.65)	(-10.82)
ξ_2 (PERIOD 2)	**-2.28**	**-2.25**
	(-13.77)	(-9.55)
ξ_3 (PERIOD 3)	**-1.67**	**-1.63**
	(10.30)	(7.01)
ξ_4 (PERIOD 4)	**-2.75**	**-2.72**
	(14.02)	(10.53)
ξ_5 (PERIOD 5)	**-1.40**	**-1.35**
	(-8.65)	(-5.81)
ξ_6 (PERIOD 6)	**-2.11**	**-2.03**
	(-11.50)	(-8.17)
ξ_7 (PERIOD 7)	**-1.42**	**-1.31**
	(7.01)	(4.93)
No. of Obs.	1094	1094

SOURCE: Socio-Economic Panel, wave 1, 1984. t-ratios in parenthesis. Piecewise constant hazards correspond to $\exp(\xi_i)$.

Table 5.6: Earnings Equations

VARIABLE	PROBIT	LEAST SQUARES
CONST	-2.86	7.08
	(-8.73)	(160.94)
MALE	-0.069	0.31
	(-0.54)	(19.86)
MARRIED	-0.23	0.076
	(-1.50)	(3.99)
SCH	-0.054	0.015
	(-1.70)	(5.12)
TRAIN	-0.058	0.008
	(-1.64)	(2.51)
GSP	-0.16	0.032
	(-1.24)	(2.30)
YSM	0.058	0.018
	(4.22)	(3.52)
YSMSQ	*	-0.00043
		(-2.59)
TUR	0.296	0.0066
	(1.63)	(0.31)
JUG	-0.019	0.079
	(-0.092)	(3.49)
ITA	-0.006	0.031
	(-0.032)	(1.37)
GR	-0.10	0.06
	(-0.47)	(2.62)
YEMP	-0.018	0.019
	(-2.36)	(8.21)
YEMPSQ	*	-0.00041
		(-7.94)
EDU	0.31	*
	(1.69)	
SCHOOL	-0.038	*
	(-0.20)	
UNEMP10	2.07	*
	(13.10)	
PART	*	-0.40
		(-11.72)
λ	*	0.10
		(3.21)
No. of Obs.	1734	1572
Adj.R^2	*	0.45

SOURCE: Socio-Economic Panel, wave 1, 1984. t-ratios in parenthesis.

Table 5.7: Discrete Time Complementary Log-Log Models

VARIABLE	(1)	(2)	(3)	(4)	(5)
EARN	-0.133	-0.173	-0.170	-0.171	-0.171
	(-2.29)	(-2.94)	(-2.89)	(-2.91)	(-2.90)
EARNT	0.086	0.097	0.097	0.097	0.097
	(2.42)	(2.70)	(2.71)	(2.72)	(2.72)
EARNG	0.069	0.091	0.092	0.091	0.091
	(1.68)	(2.20)	(2.21)	(2.19)	(2.19)
EARNS	-0.033	-0.055	-0.055	-0.053	-0.053
	(-0.74)	(-1.22)	(-1.21)	(-1.15)	(-1.16)
EARNI	0.068	0.063	0.066	0.063	0.063
	(1.63)	(1.51)	(1.57)	(1.50)	(1.49)
YSM	-0.021	-0.023	-0.024	-0.024	-0.024
	(-2.49)	(-2.75)	(-2.81)	(-2.91)	(-2.82)
AGE	0.016	0.020	0.020	0.020	0.020
	(3.79)	(4.50)	(4.52)	(4.55)	(4.56)
MALE	0.039	0.077	0.072	0.075	0.075
	(0.49)	(0.96)	(0.90)	(0.93)	(0.93)
MARRIED	0.26	0.32	0.33	0.32	0.32
	(1.78)	(2.20)	(2.27)	(2.18)	(2.18)
EDU	-0.020	-0.018	-0.015	-0.017	-0.016
	(-0.17)	(-0.15)	(-0.13)	(-0.14)	(-0.13)
SCHOOL	0.061	0.048	0.055	0.053	0.053
	(0.49)	(0.38)	(0.44)	(0.42)	(0.42)
GSP	-0.052	-0.062	-0.064	-0.061	-0.061
	(-0.75)	(-0.89)	(-0.92)	(-0.88)	(-0.88)
HSP	-0.069	-0.092	-0.090	-0.093	-0.061
	(-0.52)	(-0.70)	(-0.69)	(-0.71)	(-0.71)
TRANSFER	0.120	0.151	0.149	0.150	0.150
	(1.82)	(2.22)	(2.19)	(2.20)	(2.20)
PARTNER	-0.31	-0.38	-0.38	-0.37	-0.37
	(-2.65)	(-3.21)	(-3.23)	(-3.19)	(-3.19)
UNEMP10	0.072	0.093	0.092	0.091	0.090
	(0.93)	(1.20)	(1.18)	(1.17)	(1.16)
UNEMP	0.31	0.37	0.37	0.37	0.36
	(2.54)	(3.02)	(3.00)	(2.99)	(2.98)
α_1	*	0.049	0.067	0.115	0.098
		(8.18)	(3.92)	(3.11)	(1.34)
α_2	*	*	-0.001	-0.006	-0.003
			(-1.10)	(-1.67)	(-0.25)
α_3	*	*	*	0.0001	-0.0000
				(1.48)	(0.06)
α_4	*	*	*	*	0.0000
					(0.26)
No. of Obs.	1094	1094	1094	1094	1094
Log – Likelihood	-3023	-2993	-2992	-2991	-2991

SOURCE: Socio-Economic Panel, wave 1, 1984. t-ratios in

Figure 1: Life Table Estimates

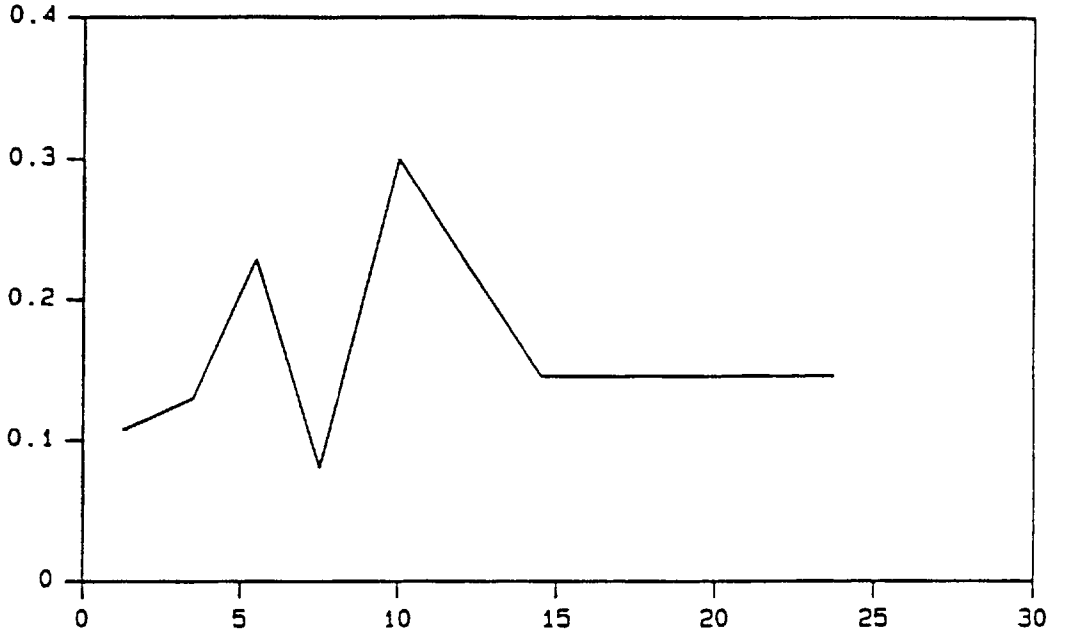

Figure 2: Cox Model Estimate of Survivor Function

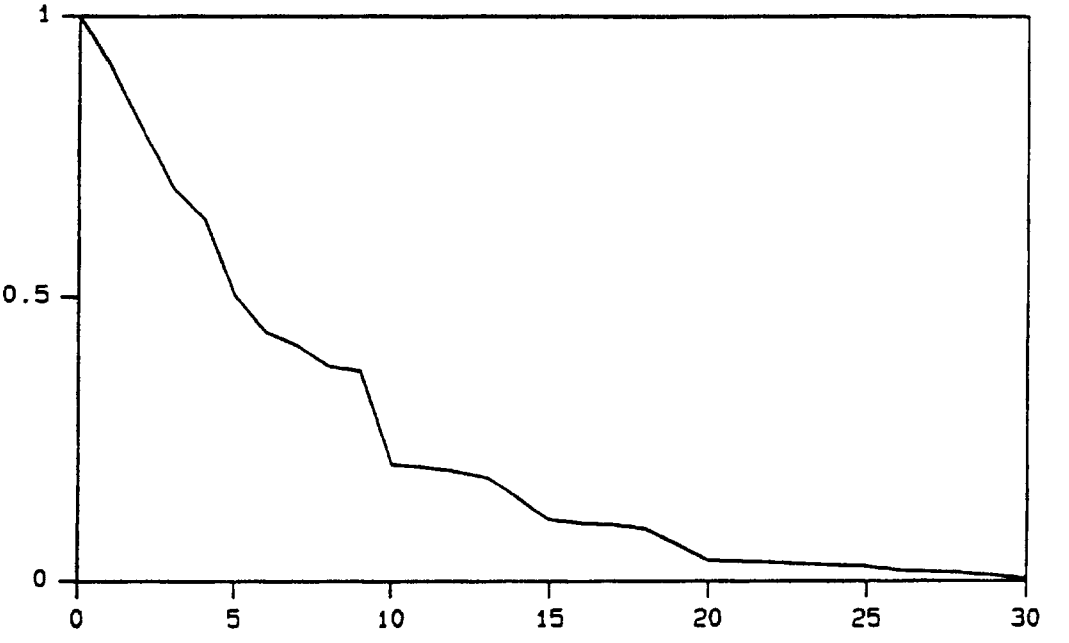

Figure 3: Piecewise Constant Hazard Rate